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(6) COST EFFECTIVE WEAPON SYSTEM SUPPORT. BRIEFING NOTES.

(16) LMI ~~PROJECT~~ 1B-5

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These briefing notes have been assembled in response to requests from the Air Force and the Office of the Secretary of Defense. They have been designed around exhibits which were prepared by LMI and used in a series of Air Force and DoD briefings.

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INTRODUCTION

The Logistics Management Institute is assisting the Department of Defense in identifying and developing improved weapon system initial support management practices and techniques. This is a continuing task which to date has been based primarily upon a series of depth studies of major weapon system programs.

In July 1962, an LMI report on the Titan II Program was released. This first ICBM system report was followed by the release of LMI's initial Minuteman Program study in March, 1963. The primary recommendations made in the two reports proposed:

- Organizations of professional Air Force provisioning specialists;
- Improved joint Service-contractor usage of weapon system support assets (spares and Wing-level support equipment, facilities and support system knowledge and data); and
- Resident Support Teams (RST's) to perform continuous and responsive efforts to derive improved support systems at reduced costs.

The material contained in these briefing notes is based upon LMI's recently completed follow-on initial support study which used the Minuteman Programs (WS-133A & B) as research vehicles. In response to requests from the Air Force and the Office of the Secretary of Defense, these notes are designed around the LMI briefing exhibits which were used in its series of Air Force and other DoD briefings. It is believed that the highly informal and somewhat unconventional character of the document produced by this method is more than offset by the time saved in avoiding the preparation of a formal report.

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SUMMARY

There is a direct correlation between approved national security goals and the number of operationally-ready weapon system units. Weapon system support program characteristics are controlling factors in the weapon's readiness posture. It follows that support system capabilities play a key role in determining the size of weapon system procurement programs required to satisfy national security goals. Accordingly, weapon system support objectives must be in close consonance with approved national security programs if precious national resources are to be expended in the most efficient manner. Much can and should be done to improve the means employed to assure this essential consonance by fully exploiting systematic, quantitative analysis techniques in the evaluation of alternative support system objectives, plans and methods.

The interrelationships which exist among a weapon system's major support elements (equipment, spares, personnel, data, etc.) dictate that a weapon system's support be planned, procured and managed as an integrated package if optimum cost effective support system postures are to be derived. Present support management methods tend to be functionally oriented (spares, personnel, etc.) rather than systems oriented. As a consequence, current support system management methods tend to stress individual functional costs rather than the total cost effectiveness of the support system. With current practices it is very difficult, if not impossible, to gauge and control total weapon system support costs and, more importantly, the weapon system's readiness status on a cost effectiveness basis. In recognition of the foregoing, it is

recommended that the DoD place emphasis on procuring and managing support systems as integrated packages. The application of the integrated support system packaging concept would assist the:

- Identification and highlighting of the critical interrelationships which exist among the individual elements of a weapon system's support elements; and

- Accomplishment of continuous trade-offs between support elements which are essential to the derivation of cost effective support system postures.

It should be noted that changes in service organizational structure are not essential to the application of the support packaging concept. Management systems necessary to facilitate the implementation of the support packaging concept are necessary. This is particularly true for multi-service weapon systems (F-4, F-111, etc.) and programs. It is recommended that the required development work be undertaken so as to permit the early application of the support packaging concept since its use would:

- Permit a more accurate identification and measurement of support system detailed and total costs;
- Provide a basis for the application and administration of incentive contracts as related to support system functions; and

- Facilitate the attainment of DoD program packaging objectives by providing an improved service control of support system costs and interrelationships.

Another support area worthy of increased managerial attention is the manner in which selected support system objectives are defined, communicated and progressively

refined. The objectives selected for the various segments of a support system (supply, maintenance, etc.) must be clearly defined in measurable terms and effectively integrated if the individual plans and actions of the numerous DoD and contractor elements involved are to lead to balanced and optimized weapon system procurement and support program postures. There is ample opportunity for improvement in this area, and improved support system cost effectiveness can also be derived by placing increased emphasis on improved methods and progressive refinement. These refinement efforts are essential to optimized cost effective support since:

- National security requirements are dynamic;
- It is often necessary to reallocate DoD funds; and
- Improved support alternatives are identified as weapon system experience is gained, particularly when augmented by periodic cost effective analyses of the support systems.

Examples of the scope of the potential benefits to be derived by such refinement actions are provided in these notes. These examples indicate that an increase in operational readiness can be obtained on the Minuteman ICBM program while concurrently realizing substantial dollar cost avoidances by applying the maintenance plans called for by a few cost effective refinement studies of the currently approved Minuteman support plan. Such benefits are merely indicative of the potential DoD benefits that can be derived by means of expanded application of available cost effective disciplines. For example, it is believed that their use to establish DoD support system repair cycles would result in reduced support system spares and equipment costs in the multi-million dollar category.

Although considerable effort has been expended over the past several years to develop and publicize various ways of utilizing cost effective support system techniques, the number of actual cases of large-scale applications are relatively small. One very significant application as used for the provisioning of Minuteman Wing level spares and support equipment is reviewed in detail in this report. This sophisticated approach to provisioning can lead to great benefits if applied to all major DoD weapon systems.

In view of the benefits inherent in these techniques, it is recommended that OSD consider taking actions to extend the use of cost effective support management techniques by the Services. It is further recommended that the Services be given guidance regarding the areas which are to be covered by the applications.

These notes also contain a discussion of the LMI concept of Resident Support Teams (RST's).* This concept calls for the establishment of teams of Service personnel at key weapon system support contractor plants.** The personnel would be assigned on a resident basis for extended time periods. The teams would perform, with data and assistance from the contractors, duties which have the common purpose of improved weapon systems support effectiveness at reduced costs. The teams would be made up of representatives of the weapon system's most directly involved Service commands. In the case of the Minuteman Program, for example, the team should probably consist

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* Covered in detail in 22 March 1963 LMI Report, "Minuteman Initial Support Study."

** In the case of the Minuteman Program, these would be the Boeing/Seattle and the Autonetics/Anaheim facilities.

of personnel from BSD, OOAMA, SAC and ATC. The recommended RST approach would permit the various Service commands to discharge their individual support system responsibilities in a more coordinated and responsive manner and with more comprehensive and current decision-making information at hand than has been possible with other arrangements. As a result, more effective consideration can be given to the interrelationships of support system elements and the cost trade-offs required to derive optimum cost effective support. The RST concept suggests a more effective decentralization of command authorities and personnel, with the individual commands retaining their functional responsibilities. Under the non-RST approach to weapon system support management, the geographic distances alone separating these organizations pose critical support integration problems since continuous and highly responsive integrated support system decisions must be rendered and implemented because of:

- The dynamic nature of support system requirements; and
- The support plan improvement opportunities that are revealed as program experience is gained.

The use of RST's would greatly facilitate these cost-effective actions by virtue of:

- Greatly reducing the communications problems prevalent in non-RST methods;
- Placing knowledgeable Service and contractor personnel in close working contact with one another on a continuous basis to facilitate a maximum interchange of their specialized support system knowledge and experience; and
- Creating an improved performance incentive for individuals and organizations since the support system's cost effectiveness

can be more readily associated with individuals than is possible using non-RST methods.

A summary of LMI's Minuteman RST recommendations follows:

- Establish Minuteman RST's at the Boeing and Autonetics plants with full-time representation from BSD and OOAMA and frequent part-time participation by SAC and ATC;

- Assign the following duties to the teams:

  (1) Spares order release and modification.

  (2) Day-to-day HI-VALUE spares management.

  (3) Competitive spares breakout analyses.

  (4) Provision of focal points for Service-contractor Minuteman support system planning.

  (5) Refinement of Minuteman maintenance and repair plans (relief mobile teams, depot versus base level repair, SAC manning requirements, etc.).

  (6) Derivation and application of refined A & CO and Air Force spares requirements determination methods;

- Develop and apply performance measures to the RST's; and

- Restrict incremental provisioning parts breakdown (IPPB) to items selected for spares procurement or local manufacture.

LMI's RST recommendations were first presented to the Air Force on 28 September 1962 and were partially implemented by 7 January 1963. The Air Force is still in the

process of evaluating the benefits to be derived by the full-scale application of the RST recommendations. It has been suggested that the Air Force fully implement the recommended RST concept on the Minuteman and F-4 programs.

SECTION I: BACKGROUND MATERIAL

A. INTEGRATED SUPPORT SYSTEM PACKAGING CONCEPT AND COST EFFECTIVE WEAPON SYSTEM SUPPORT

BASIC SUPPORT SYSTEM ELEMENTS

- SUPPORT OBJECTIVES AND GOALS
- SUPPORT CONCEPTS AND PLANS
- SUPPORT EQUIPMENT
- SPARES (EQUIPMENT AND REPAIR PARTS)
- SUPPORT PERSONNEL
- SUPPORT TECHNICAL DATA
- SUPPORT FACILITIES
- SUPPORT TRANSPORTATION AND SUPPLY SYSTEMS
- SUPPORT MANAGEMENT SYSTEM

EXHIBIT NO.1

BASIC SUPPORT SYSTEM ELEMENTS

Exhibit #1 lists the basic elements contained in well-formulated weapon support systems. A few points are made with respect to each of these closely interrelated elements.

(1) Support Objectives and Goals - There is a direct correlation between approved national security goals and the number of operationally ready weapon system units required. A weapon system's support program is a controlling factor in the weapon system's readiness posture. In short, the support system's capabilities play a key role in determining the number of weapon system units which must be procured in order to satisfy the national security goals. Therefore, unless the weapon system's support objectives are in consonance with national security programs, precious national resources (funds, personnel, facilities and time) will be expended in an inefficient manner. Systematic, quantitative analyses of support systems* are required to supplement and complement experience and judgment if cost effectiveness is to be adequately considered in realizing national security objectives.

A weapon system's support objectives should be specified in clear and measurable terms. There are many geographically distant and organizationally distinct groups involved in establishing a weapon system's support system characteristics. Unless they are provided with clearly defined support objectives, it is unlikely that their individual plans and actions will lead to a well-integrated and optimized weapon system support posture.

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* Examples of these techniques are covered in subsequent parts of these notes.

A weapon system's support objectives need to be progressively refined to obtain efficient utilization of resources. This is the case since:

- National security requirements are dynamic;
- Reallocation of funds within DoD are often necessitated for a variety of reasons; and
- Improved support alternatives typically reveal themselves during the course of performing systematic, quantitative support system analyses.

(2) Support Concepts and Plans - Integrated support concepts and plans must be decided upon as the means of achieving desired support objectives. There are a wide number of materially different alternative support plans available. By systematically analyzing the alternative routes, the most economical and effective plan can be identified. The many interrelated support system elements involved make it necessary to compare the cost effectiveness of the numerous available alternative plans. In addition to balancing the support elements used to build a support plan, decisions, also based upon relative cost effectiveness, are required with respect to such matters as:

- The degree to which contractor support will be relied upon;
- The division of support tasks between depots and operational bases;
- The timing of support element procurements and support system implementation;

- The determination of the optimum repair cycle times for each major piece of weapon system equipment; and
- The decision whether it is more economical to repair or to throw away each type of weapon system part and equipment after failure.

Throughout most of the life of a weapon system the cost effectiveness of the support concepts and plans can be continuously improved through the use of:

- Experiences and knowledge gained during the course of acquiring, activating and operating the weapon system;* and
- Improvement opportunities revealed by the progressive utilization of systematic quantitative support system analyses.**

Brief descriptions of the resources which must be covered in support plans and concepts are set forth below.

(3) <u>Support Equipment</u> - Weapon system equipment which is used to maintain and repair the system but which is not required to execute the weapon system's operational mission is generally referred to as weapon system support equipment. Such equipment is used to:

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* The use of the Resident Support Team (RST) concept, which is reviewed later in this report, can facilitate this.

** Some of the kinds of opportunities provided by this means are illustrated in subsequent report material.

- Assist in identifying defective weapon system equipment, components and parts. Test consoles and portable test sets are familiar examples of support equipment used for these fault isolation functions;

- Facilitate weapon system repair and maintenance tasks. Examples of support equipment used for these purposes include such things as tools, handling equipment, support communication systems, maintenance vans and support personnel carriers;

- Monitor the operational readiness state of the weapon system. An example of support equipment used for these purposes would be the remote fault indicating panels located in each Minuteman launch control center to indicate the operational status of each of its flight launch facilities; and

- Assure the adequacy and completeness of repair and maintenance actions. These repair check-out functions usually employ the same support equipments used for fault isolation and readiness monitoring.

(4) Support System Spares (Equipment and Repair Parts) - These are the weapon system components and repair parts which are procured in anticipation of their being required for the performance of maintenance and repair operations on weapon system equipments. They are the backbone of the support system. The difficulties associated with arriving at optimum positions with respect to the range, quantity and deployment of spares are well recognized. During the Minuteman Program initial support study, LMI made a detailed analysis of a spares provisioning technique which holds promise of significantly increasing the cost effectiveness of spares support. This technique is discussed in some detail in subsequent pages.

(5) <u>Support System Personnel</u> - A sufficient supply of support system personnel is the key ingredient in all support systems. Without it, all of the other support assets would sit idle. The planning for support manpower needs to be done as an integrated part of total support planning with required readiness and maximum over-all cost effectiveness as the objective. With such an approach, a greatly improved basis is obtained for establishing the support personnel skills and quantities required and for factoring in such things as turnover, the degree of flexibility permitted in organizational and task assignments and related training schedules. Any tendencies toward arbitrarily established restraints in these areas must be challenged if required readiness and minimum total costs are to be assured. Manpower decisions should be based upon cost effectiveness measures which are backed by the recorded quantitative analyses of alternative support system plans.

(6) <u>Support System Technical Data</u> - This area consists of the various manuals, illustrations and instructions which are procured to assist support personnel in the performance of maintenance and repair tasks. Maintenance manuals and technical orders are familiar examples of these data. This area is under current scrutiny by the DoD in an effort to eliminate redundant or otherwise non-essential data.

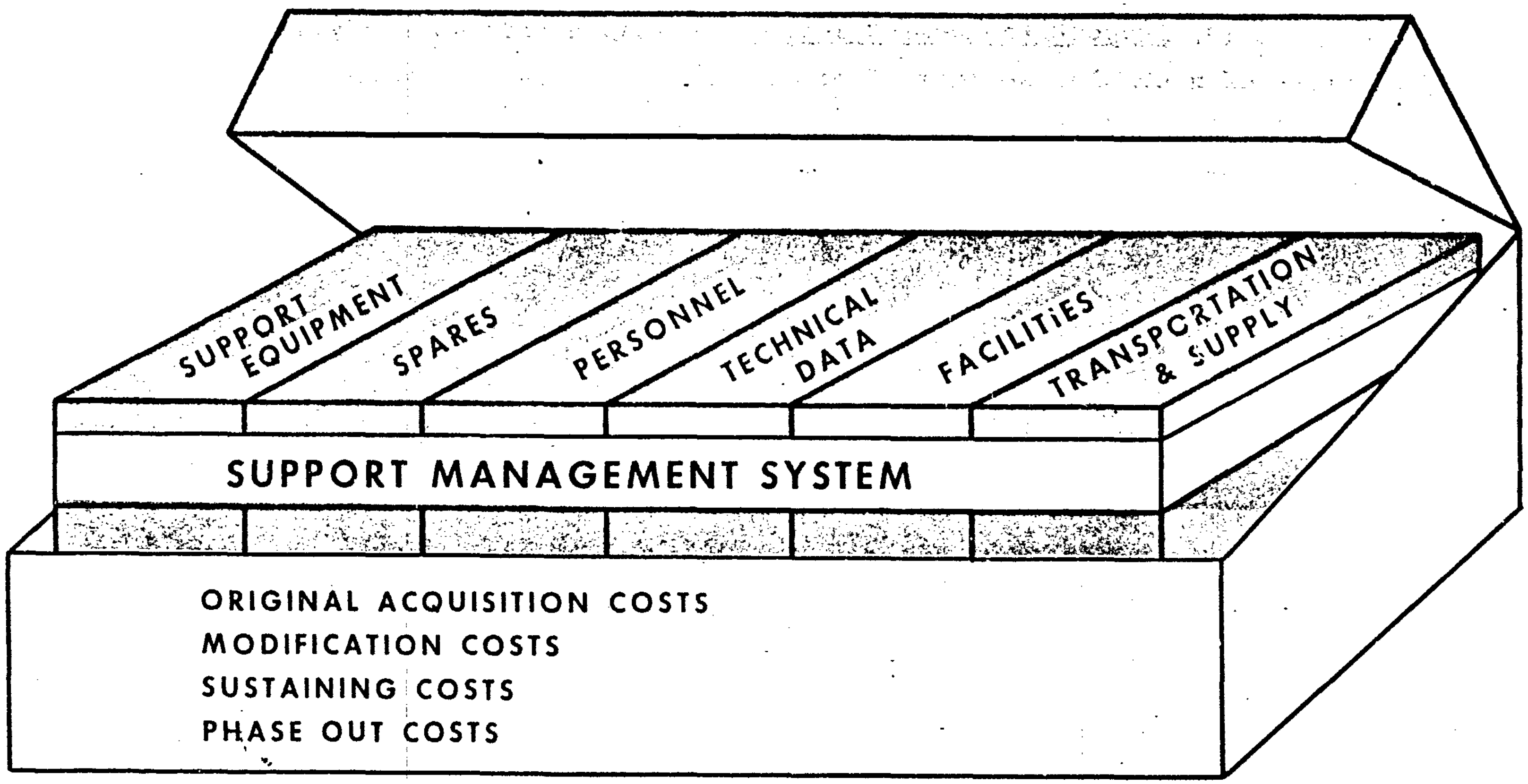
(7) <u>Support System Facilities</u> - These are the facilities which are required to house the other support system elements at the field, organizational and depot levels.

(8) <u>Support Transportation and Supply Systems</u> - These are the elements which permit the planned movements of support system elements to take place. Included

in this area are the familiar system conveyances such as railroads, airplanes, trucks and ships and the data processing and communications networks and facilities required to make them productive.

(9) Support Management System - A weapon program's support management system consists of a complex amalgam of organizational units, procedures, authorities, responsibilities and controls. The degree to which the individual elements function as an integrated, responsive and efficient entity is a major factor in determining the efficiency with which a selected weapon system support plan is executed.

INTEGRATED SUPPORT SYSTEM PACKAGE



- SUPPORT OBJECTIVES & GOALS
- SUPPORT CONCEPTS & PLANS
- SUPPORT FUNDS

EXHIBIT NO.2

INTEGRATED SUPPORT SYSTEM PACKAGES

The interrelationships which exist among a weapon system's major elements are so important that the elements should be planned and managed as an integrated whole. Such treatment requires the development and application of a sophisticated support management system. The development of an optimum weapon system support posture requires the making of optimum cost effectiveness trade-offs among alternative support plans employing different mixes and combinations of the support elements portrayed in Exhibit #2. Before systematic trade-off studies can be performed, a management system must be developed which establishes and highlights the interplay among the individual support system elements.

Service organizational structure changes are not required to implement the concept of procuring weapon support systems as a package. The basic management tools, techniques and capabilities required to develop such a management system are already in being. A great deal of complex management systems development work would be required, however, to make it possible to make the resource trade-offs among elements and organizations that would be called for by cost effectiveness studies which embraced all of the support system elements. For example, if analysis revealed that a $2,000,000 increase in support equipment expenditures would yield a $4,000,000 savings in spares, it should be possible to make, on a timely basis, the funding, contractual and other adjustments necessary to permit the money-saving action. Similar interrelationships among such elements as personnel resources, support equipment and spares, can be cited as illustrations of where resource reallocations would be called for to effect

total savings. In multi-Service weapon systems, re-allocations of resources among Services would undoubtedly be logical from time to time. The procedures necessary to accomplish this should be developed.

One purpose of this brief review of the integrated support system package concept is to stress the great potential of the concept for improved weapon system support and to identify some of the management challenges that must be overcome if it is to be applied with full effectiveness. Another purpose is to call attention to the fact that the concept's application would effectively augment DoD's current program packaging system by facilitating the measurement and control of a weapon system's support costs.

COST EFFECTIVENESS

- COST EFFECTIVENESS
  - A MEASUREMENT OF DoD DOLLAR EFFICIENCY

$$\text{DoD COST EFFECTIVENESS} = \frac{\text{\$EQUIVALENT OF DoD INPUTS}}{\text{DoD EFFECTIVENESS CRITERIA}} = \frac{\text{INPUT}}{\text{OUTPUT}} = \frac{1}{\text{EFFICIENCY}}$$

- GENERAL APPLICATION
  - DOLLAR EVALUATION OF ALTERNATIVE MEANS OF SATISFYING DoD OBJECTIVES
- SPECIFIC APPLICATION IN THIS REPORT
  - COST EFFECTIVE WEAPON SYSTEM SUPPORT

EXHIBIT NO.3

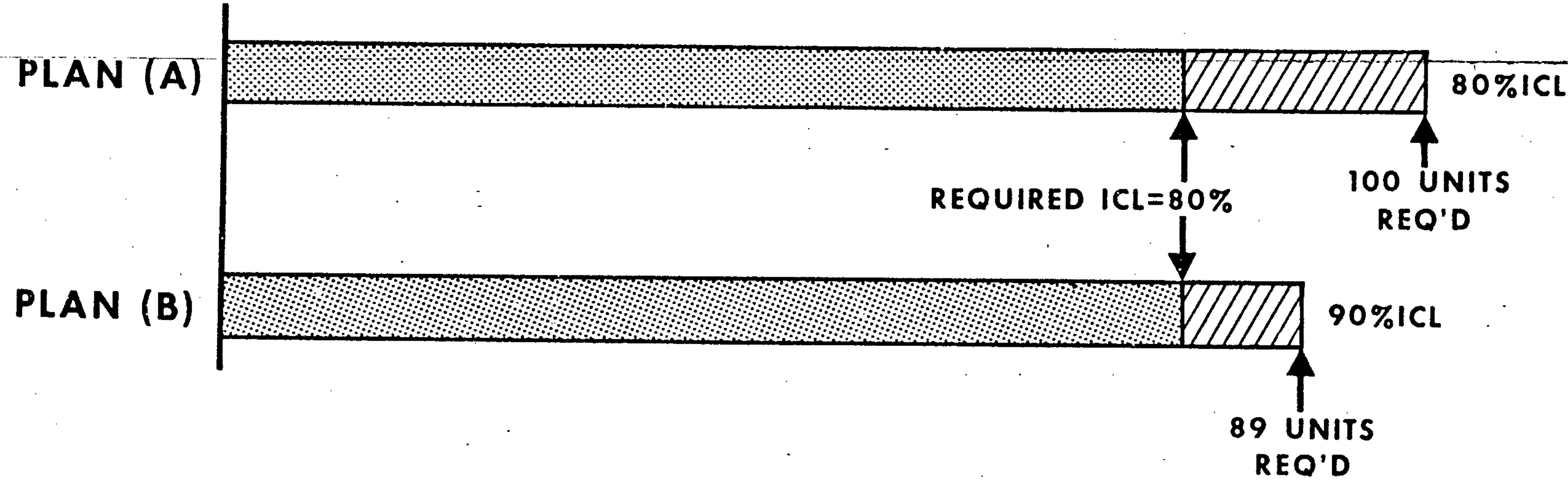
COST EFFECTIVENESS

The term "cost effectiveness" appears frequently in these notes. While the term is in widespread use throughout the DoD, it nevertheless is probably desirable to clarify LMI's interpretation of it. As viewed by LMI, the term "cost effectiveness" implies that measurements of relative efficiency have been performed with respect to applied or potentially applied DoD resources. In other words, it is a measurement of DoD dollar efficiency. It is used to provide a quantitative comparison of the alternative ways in which DoD resources may be applied to satisfy DoD objectives. Since the measurement's application requires the conversion of the resources required by alternative plans to their dollar equivalent, the concept's application by DoD can be described as a dollar evaluation of alternative means of satisfying DoD objectives.

Cost effectiveness is applied for a wide variety of purposes by DoD. For example, it can be used to compare different force groupings or it can be used to compare the different mixes of weapon systems (Polaris submarines versus Minuteman missiles, B-52's versus Atlas or Titan missiles, etc.). As used in these notes, however, the cost effectiveness applications are primarily directed toward alternative weapon system support plans and postures. With respect to weapon system support matters, cost effectiveness techniques can prove of material assistance in:

- Determining the most cost effective relationships among a weapon system's procurement and support plans; and
- Determining the most cost effective support system plan for weapon systems.

WEAPON SYSTEM PROCUREMENT AND SUPPORT SYSTEM PLANNING



PLAN (A)

ACQUISITION COSTS + SUPPORT COSTS=TOTAL

(100 UNITS×\$1,000,000/UNIT) + \$10,000,000=\$110,000,000

PLAN (B)

ICL RAISED TO 90% BY \$5,000,000 INCREASED SUPPORT

NUMBER OF REQUIRED WEAPON SYSTEM UNITS=$\frac{80}{0.9}$=89 UNITS

PLAN (B) NET SAVINGS=PROCUREMENT SAVINGS MINUS HIGHER SUPPORT COSTS

=(100-89)(\$1,000,000)-\$5,000,000

=**\$6,000,000**

EXHIBIT NO.4

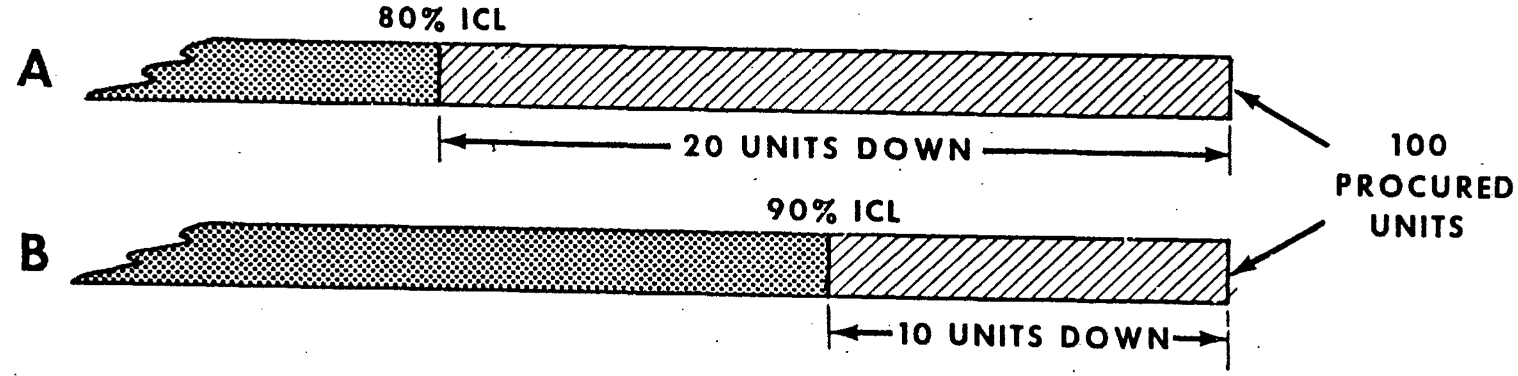
WEAPON SYSTEM PROCUREMENT AND SUPPORT SYSTEM PLANNING

Exhibit #4 contains two hypothetical cases which illustrate how cost effective support planning can be applied to assist in quantifying a weapon system's procurement program. In the case of the hypothetical weapon system, assume that JCS has ascertained the need to have an average weapon system readiness of 80 war-ready units. Under Plan (A) the planned procurement buy of 100 units was based upon a combination of contractor inputs as to the weapon system's reliability characteristics and DoD estimates of the average in commission level (ICL) that can be expected using past weapon system experiences as a guide. Plan (B) represents an alternative plan which was arrived at using disciplined cost effective (C/E) support planning techniques. In this assumed case, these C/E techniques revealed that under Plan (A) there would be a serious support element queueing condition which could be eliminated by spending $5,000,000 more for various support elements. Eliminating this limiting queueing situation permitted the ICL to be raised to 90%. This increased ICL permitted a reduction in the number of weapon system units that had to be planned on in order to assure JCS's required readiness of 80 war-ready units.

The calculations shown on the exhibit have been purposely simplified in order to facilitate showing how C/E support techniques can be applied. When C/E support techniques are applied to actual situations, careful consideration would have to be given to a series of alternative plans. In addition, it would be necessary to analyze the possible effect that different sized procurements would have on such things as weapon system unit costs. The cases portrayed on the exhibit simply illustrate that

the systematic analysis of quantitative cost trade-offs called for by C/E support planning disciplines may lead to very sizable total cost savings while not compromising weapon system readiness considerations.

COST EFFECTIVE WEAPON SYSTEM SUPPORT PLANNING



- **PLAN (A)**
  - ACQUISITION + SUPPORT COSTS = $110,000,000
  - ICL = 80%
  - COST PER WAR READY UNIT = $\frac{\$110,000,000}{80}$ = $1,375,000
  - DOLLAR VALUE OF UNITS DOWN = 20 ($1,375,000) = $27,500,000
- **PLAN (B)**
  - $5,000,000 ADDITIC ‚IAL SUPPORT
  - ICL = 90%
  - ACQUISITION + SUPPORT COSTS = $115,000,000
  - COST PER WAR READY UNIT = $\frac{\$115,000,000}{90}$ = $1,277,778
  - DOLLAR VALUE OF UNITS DOWN = 10 ($1,277,778) = $12,777,780

EXHIBIT NO.5

COST EFFECTIVE WEAPON SYSTEM SUPPORT PLANNING

The hypothetical case just reviewed showed how C/E support planning techniques might be used to reduce costs by assisting planners in making refined weapon system sizing determinations. The hypothetical case displayed on Exhibit #5 shows how C/E support techniques can be used to assist planners in arriving at a more nearly optimum weapon system support posture. In the plans portrayed,* it is assumed that the 100 weapon system units are in their early stages of acquisition and C/E support techniques have been utilized to refine Plan (A), which was the originally configured support system. It is assumed that the C/E analyses have revealed that an additional expenditure of $5,000,000 for support purposes will raise the ICL from 80% to 90%. As shown on the exhibit, this expenditure will provide an additional 10 war-ready units in the inventory. In effect, the additional $5,000,000 has made it possible to maintain an otherwise idle weapon investment of $14,722,220 in a war-ready posture.

In actual practice, the applications portrayed separately on Exhibits #4 and #5 would be worked in combination with each other so as to help assure that a procurement of optimum size is supported in an optimum manner. In the material which follows, examples are provided which show how C/E support techniques have been used in this manner to improve the Air Force's Minuteman Programs.

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* Plan (A) on Exhibits #4 and #5 are identical.

B. THE CURRENT MINUTEMAN
COST EFFECTIVENESS PROVISIONING MODEL

LMI'S STUDY OF MINUTEMAN COST EFFECTIVE PROVISIONING METHODS

During its first initial support study of the Minuteman Program,* LMI learned about a new cost effective provisioning method which Boeing's Aerospace Division had developed for the Air Force. These new C/E provisioning tools are currently being used on the Minuteman Programs. One of the major purposes of LMI's second detailed initial support study of the Minuteman Program was to gain further insight into the Minuteman C/E provisioning method and to ascertain the degree to which it is applicable to other programs. This second LMI Minuteman project, which was conducted during the period of 22 April through 21 June 1963, led LMI to three conclusions, namely:

(1) The Minuteman C/E provisioning method represents a major advance in the development of improved and readily applicable provisioning techniques. The method provided Minuteman weapon system management and provisioners with a set of sound and sophisticated provisioning tools which should prove of great interest to all weapon system planners and logisticians;

(2) The same basic C/E approach to provisioning can be applied to improve the provisioning proficiency on other weapon systems;

(3) The concepts employed in the development of the Minuteman provisioning techniques can be broadened to develop more

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* Covered in LMI's 22 March 1963 report titled, "Minuteman Initial Support Study." This report is classified "SECRET."

sophisticated C/E weapon system support plans which should accelerate the rate at which weapon system costs are reduced and support system effectiveness is improved.

The next group of exhibits is devoted to Minuteman C/E provisioning methods. A review of these exhibits will disclose that the Minuteman C/E provisioning method can be used as a means of approaching an optimum weapon system support posture similar to that portrayed in Exhibit #5.

OBJECTIVE OF MINUTEMAN COST EFFECTIVENESS PROVISIONING

- **OBJECTIVE:**

  TO DETERMINE THE QUANTITY OF SUPPORT SYSTEM ELEMENTS (SPARES, SUPPORT EQUIPMENT, MEN ETC.) REQUIRED TO MINIMIZE THE TOTAL COST PER OPERATIONAL WEAPON SYSTEM UNIT.

- **RATIO TO BE MINIMIZED:**

$$R = \frac{\text{TOTAL COST OF PROCURED WEAPON SYSTEM}}{\text{NUMBER OF OPERATIONAL WEAPON SYSTEM UNITS}}$$

EXHIBIT NO.6

OBJECTIVE OF MINUTEMAN COST EFFECTIVENESS PROVISIONING

The objective sought by the developers of the Minuteman Program's C/E provisioning technique was a sound analytical tool which would identify the number of Wing level support elements required to derive an optimum balance between support element costs and weapon system downtime costs caused by weapon system element queueing. Using broader terms, this objective can be defined as shown on Exhibit #6, where is is expressed as a ratio which must be minimized if the objective is to be attained. The manner in which this ratio is quantified is explained later in this presentation.

MINUTEMAN COST EFFECTIVENESS PROVISIONING METHOD

- **BASIC PREMISE:**

  WEAPON SYSTEM DOWNTIME (I.E., ITS OUT OF COMMISSION TIME) COSTS MONEY

- **DOWNTIME COST:**

$$\text{DOWNTIME COST} = \frac{C_A + C_S}{L} = \text{\$ PER UNIT OF TIME}$$

WHERE;

C_A = WEAPON SYSTEM ACQUISITION COSTS

L = PLANNED WEAPON SYSTEM SERVICE LIFE

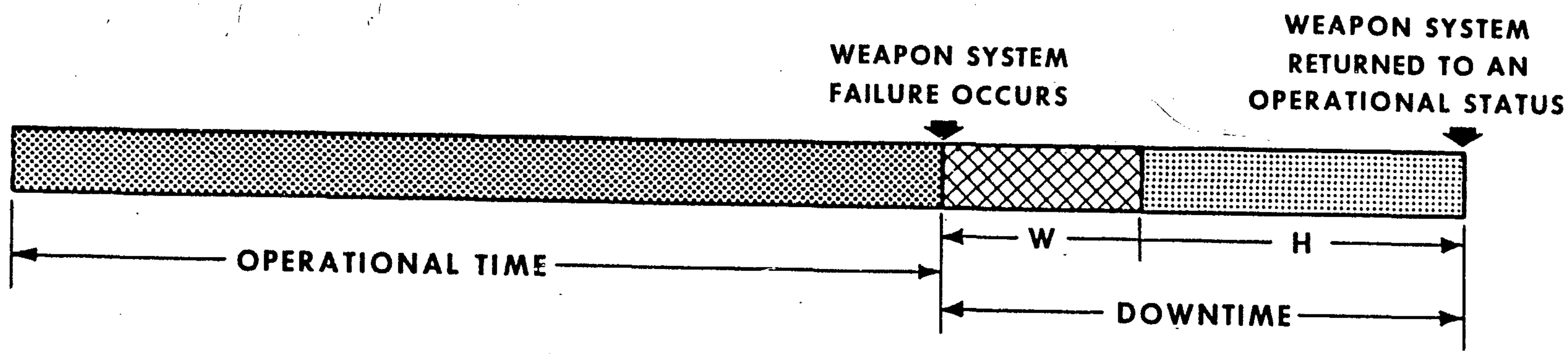
C_S = WEAPON SYSTEM SUPPORT COSTS DURING ITS SERVICE LIFE PERIOD

EXHIBIT NO. 7

MINUTEMAN COST EFFECTIVENESS PROVISIONING METHOD

As shown on Exhibit #7, the C/E provisioning method's basic premise is that weapon system downtime (i.e., its out-of-commission time) costs money. In order to help illustrate this point, the generalized equation shown on Exhibit #7 can be applied. In essence this equation says that the dollars expended in acquiring and supporting a weapon system are of potential value only during the weapon system's service life period.

WEAPON SYSTEM DOWNTIME



- **W** REPRESENTS THE TIME CONSUMED IN WAITING FOR THE AVAILABILITY OF SUPPORT SYSTEM ELEMENTS REQUIRED TO MAKE THE REPAIRS CALLED FOR. THIS IS KNOWN AS THE QUEUEING ELEMENT.

- **H** REPRESENTS THE TIME REQUIRED TO MAKE THE REQUIRED REPAIRS. THE TWO MAJOR ELEMENTS ARE:

  — THE TIME CONSUMED IN RESPONDING TO THE FAILURE

  — THE TIME CONSUMED IN PERFORMING THE REPAIR ACTIONS CALLED FOR BY THE REPAIR PLAN

EXHIBIT NO. 8

WEAPON SYSTEM DOWNTIME

Exhibit #8 displays an early step in applying the Minuteman* C/E provisioning technique to reduce weapon system downtime. Downtime is divided into two major parts. The first part is the queueing element (W), and the second part (H) is the amount of downtime consumed in performing the repair actions called for by the specific weapon system failure that has been experienced.

The M^2 C/E provisioning technique is directed at reducing the queueing element (W) to an optimum cost effectiveness level. To achieve that objective, it is necessary to provision each queue-causing support system element so as to balance the cost of providing these elements and the cost of the downtime prevented. In other words, the cost of the support elements provided must be at least counterbalanced by the value of queueing time saved. In the M^2 Program, this is the basis for provisioning each M^2 Wing's spares and ground support equipment.

Exhibit #8 also portrays the downtime element (H), which is dependent upon the proficiency with which these support elements are applied. (H) is dependent upon the M^2 support plan. This plan establishes the amount of time that will be consumed in:

- Recognizing the occurance of a failure and performing the repair planning and scheduling tasks. (This is the failure response time.); and

- Performing the repair actions called for by the repair plan.

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* Hereafter, the word Minuteman will be represented by the symbol "M^2."

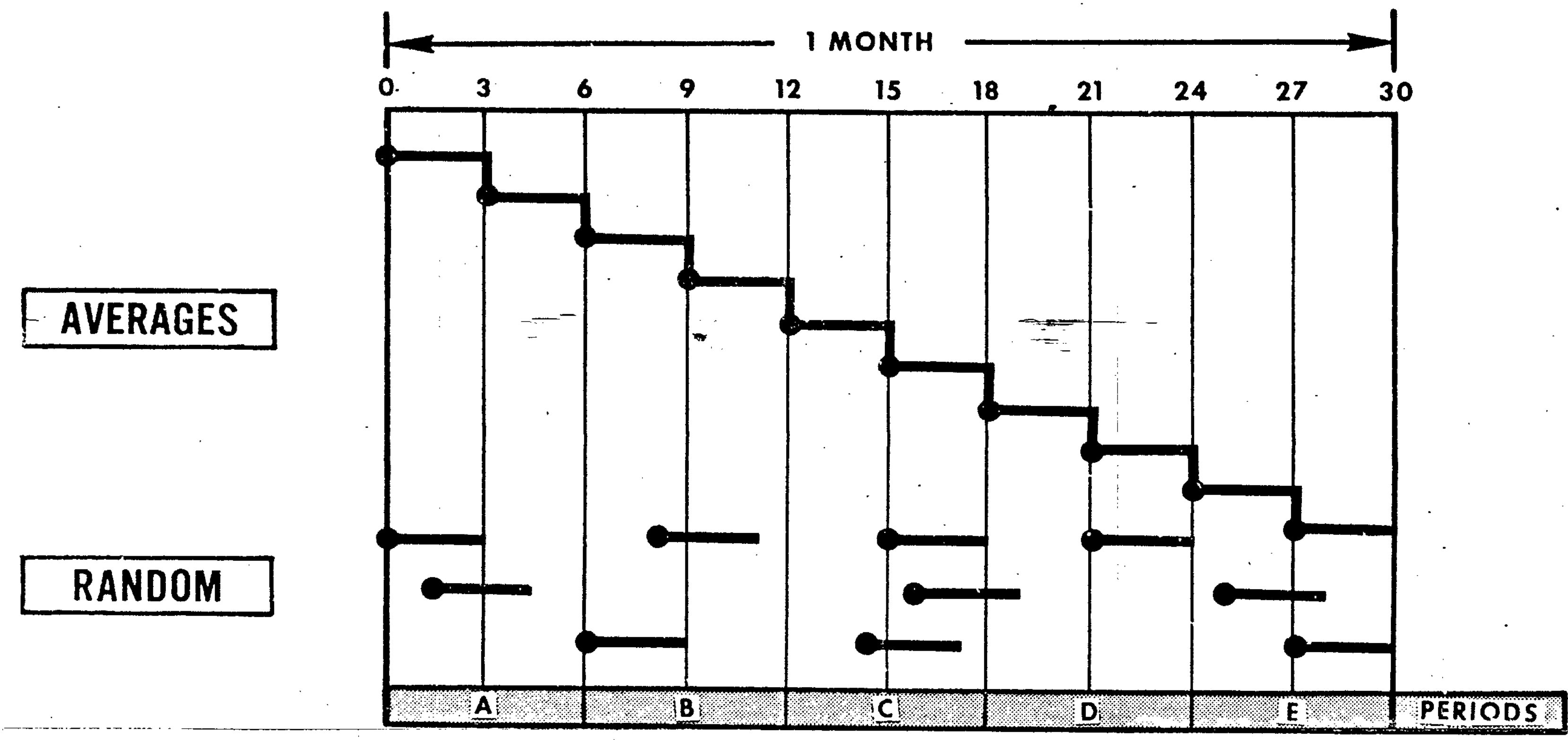
RANDOM VS. AVERAGE FAILURES

ASSUMED CONDITIONS

10 FAILURES PER MONTH

3 DAY REPAIR CYCLE

● ● MARKS OCCURRENCE OF A FAILURE



• CONCLUSION:

QUEUEING MUST BE CONSIDERED IF DOWNTIME DUE TO A LACK OF SUPPORT ELEMENTS IS TO BE MINIMIZED.

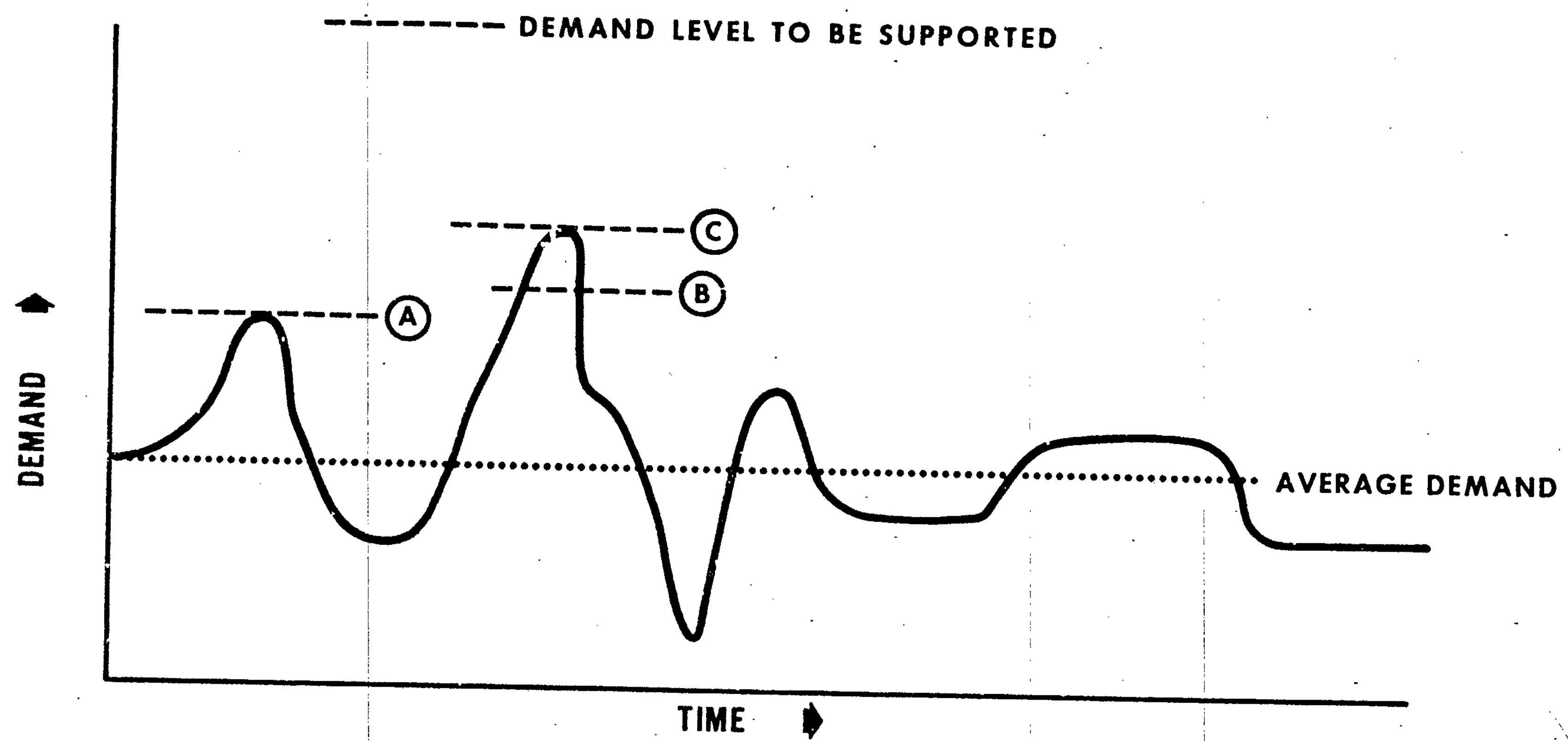
EXHIBIT NO.9

RANDOM VERSUS AVERAGE FAILURES

Exhibit #9 shows how the general queueing principle is applied to the specifics of a weapon system support element demand analysis. In the case portrayed, it is assumed that reliability disciplines have revealed that a weapon system component will experience ten failures per month. It is further assumed that after the failed component has been removed from the weapon system, three days will be required to repair the failed unit and place it back in the support system's stock of repair components. Under these assumed conditions, only one spare component would be required in the support system if the ten failures occured exactly as indicated by averaging calculations.* In other words, on the basis of averages, the failed component would be ready at the end of three days which would be in time to permit its serving as a spare for the next weapon system failure. Weapon system failures, however, occur in a random manner similar to that shown on Exhibit #9. If downtime due to queueing were to be eliminated in the case shown, two spares would be required during periods A, B, D and E, whereas three spares would be required during period C. Accordingly, if downtime due to the lack of available support elements were to be eliminated, three spares would be required in the support system. The decision as to whether 1, 2 or 3 spares are to be carried must be based upon queueing considerations if an optimum balance is to be achieved between support element costs and weapon system downtime costs. Spares were used as the example in this portrayal. The same queueing considerations apply to support equipment, facilities and repair personnel.

* $\frac{\text{30 Days/Month}}{\text{10 Failures/Month}}$ = 3 Days Between Failures.

FLUCTUATING DEMAND FOR SUPPORT ELEMENTS



- **CONCLUSION:**

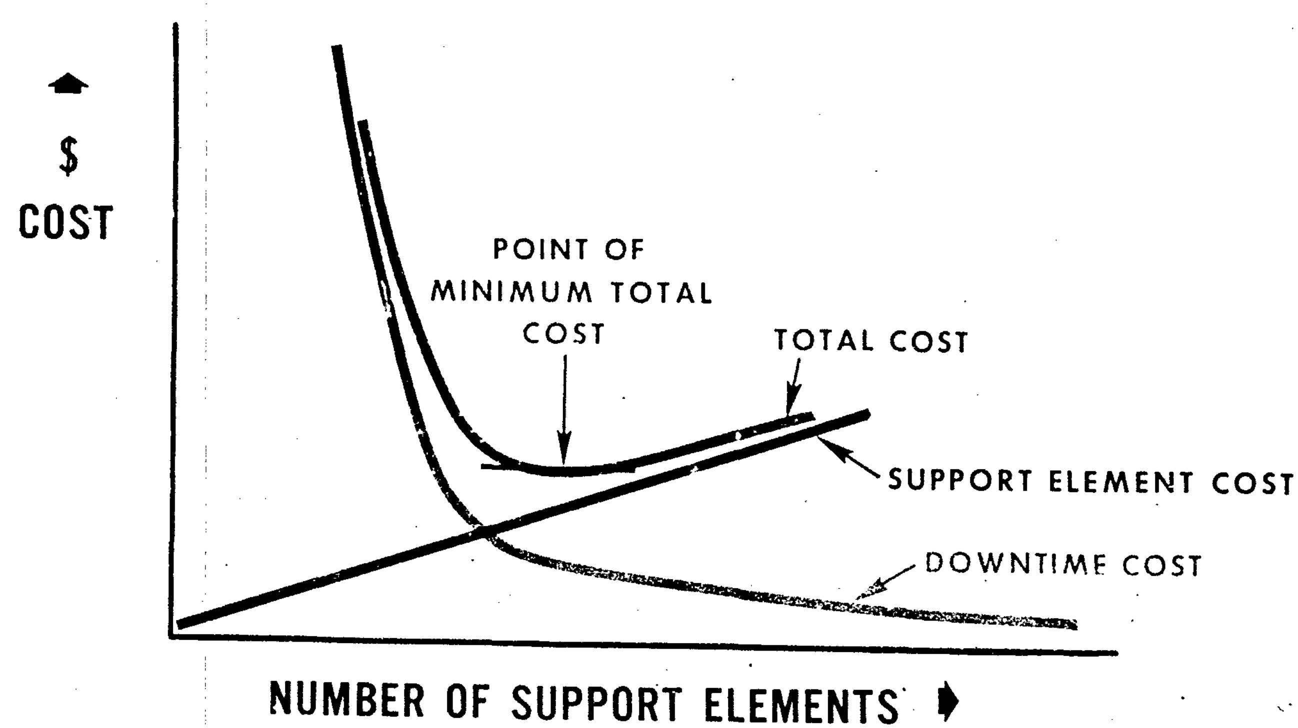
  SYSTEMATIC QUANTITATIVE C/E ANALYSES TECHNIQUES MUST BE USED TO IDENTIFY THE DEMAND LEVEL TO BE SUPPORTED IF OPTIMIZED COST EFFECTIVE WEAPON SYSTEM SUPPORT IS TO BE DERIVED.

EXHIBIT NO.10

FLUCTUATING DEMAND FOR SUPPORT SYSTEM ELEMENTS

Exhibit #10 is another way of illustrating the manner in which the random occurrences of weapon system failures affect the demand for support system elements. If simple averaging calculations were used to arrive at support element provisioning decisions, it is apparent that excessive downtime would be experienced because of queueing. By the same token, the arbitrary selection of some such demand level as A, B or C on Exhibit #10 may lead to excessive support costs. Because of the complex cost interrelationships involved, systematic C/E analyses techniques must be used to identify the demand level that should be used as a provisioning base if the weapon system is to be supported in an optimum C/E manner.

M^2 SUPPORT COST OPTIMIZATION



- **PROBLEM:**

DETERMINATION OF MINIMUM COST POINT

EXHIBIT NO. 11

MINUTEMAN SUPPORT COST OPTIMIZATION

Exhibit #11 illustrates the general relationship between the quantity of provisioned support elements and costs. As the numbers of support elements provided are increased, their costs will increase while concurrently lowering downtime queueing costs in the manner shown. The problem facing provisioners is the identification of the number of support elements which will produce the minimum total cost.

DETERMINATION OF THE MINIMUM TOTAL COST POINT

- **METHOD:**
  - —DEVELOP A MATHEMATICAL EXPRESSION WHICH YIELDS THE AMOUNT OF DOWNTIME THAT WILL BE EXPERIENCED WITH ANY GIVEN NUMBER OF SUPPORT ELEMENTS.

- **BASIC CONSIDERATIONS:**
  - —TOTAL COST OF THE WEAPON SYSTEM
  - —COST OF EACH SUPPORT ELEMENT STUDIED
  - —MTBF OF A MINUTEMAN LAUNCH FACILITY
  - —AVERAGE LAUNCH FACILITY DOWNTIME
  - —APPLICABLE QUEUEING MODEL

EXHIBIT NO. 12

DETERMINATION OF THE MINIMUM TOTAL COST POINT

In order to find the minimum total cost point (see Exhibit #10) for the M^2 support system elements, Boeing had to develop a mathematical C/E expression which could yield the amount of downtime that would be experienced with any given number of support elements. In developing this mathematical expression, the basic considerations shown on Exhibit #12 were analyzed. The queueing portion of the mathematical model was based upon Molina's 1927 queueing analysis as applied to telephone trunking circuits* and includes the:

- Support element demand frequency (equipment failure rates and an exponential distribution);
- Repair cycle times required for failed support system elements (a constant of 3 days was selected); and
- Priority of repair of failed weapon system elements (first-come, first-served).

The expression which was developed was applied to each M^2 support system element used in replacing failed elements at the launch control and launch facilities.

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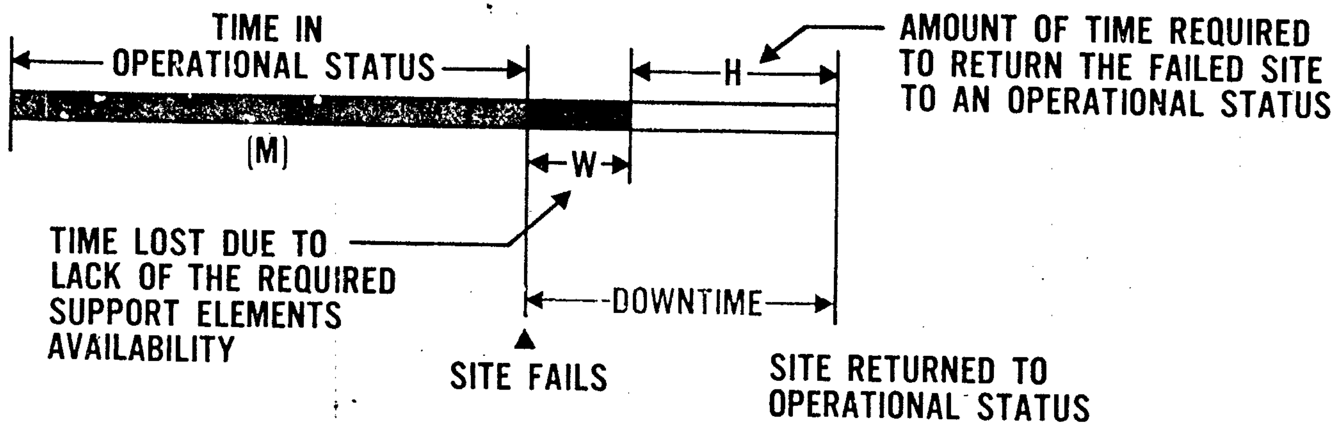
* Molina, E. C., "Application of the Theory of Probability to Telephone-Trunking Problems," System Technical Journal, Vol. 6, p. 461, 1927.

MISSILE IN COMMISSION LEVEL [MICL]



$$\text{MISSILE IN COMMISSION LEVEL} = \left[\frac{M}{M+W+H}\right]$$

EXHIBIT NO. 13

MISSILE IN COMMISSION LEVEL (MICL)

The M^2 mathematical C/E expression developed by Boeing is known as the M^2 C/E Provisioning Model. One of the principal parts of this model is an expression of the M^2 missile in commission level (MICL).

The MICL expression (Exhibit #13) is a time-efficiency equation. The MICL numerator M (output) is the amount of time that a Wing's missiles will be in an operable (launch-ready) status. The MICL denominator of M+W+H (input) is the total amount of time associated with obtaining the operable status.

(1) M represents the mean time between a M^2 launch facility's no-go (launch-preventing) failures. M's value is based upon the approved Air Force reliability figures for each piece of operating equipment.

(2) W represents the weighted average time that an inoperable launch facility must wait for the availability of the support element under consideration. The mathematical expression for W (which uses the Molina queueing model) is a complex function of:

- The demand frequency for the support element;
- The number of the support elements provisioned; and
- The average time that the support element is in use as a replacement element in one missile and therefore not available as a spare to repair other missiles.

(3) H represents the average weighted downtime during all the Wing's launch facility no-go failures. This figure is

arrived at by making a detailed analysis of the downtime associated with each of the many types of monthly no-go failures. The elements of this downtime are:

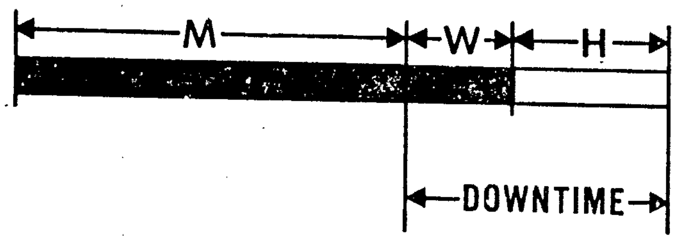
- The amount of elapsed time between the point of failure detection and the point of dispatching the repair crew and support elements required for the failure's repair;
- The amount of time consumed by the repair crew in traveling from the Wing's support base to the failed site;
- The amount of on-site time required to isolate the failure, remove and replace the failed unit and return the site to a strategic alert status;
- The amount of time the repair crew is at rest when a repair job requires an overnight layover in the field in order to complete the job; and
- The amount of time required to penetrate and resecure the failed site's security system and meal-time allowances.

Since the objective in the M^2 weapon system is to have missiles in a strategic alert status, the MICL, in addition to being a time-efficiency measure, is the effectiveness ratio of the C/E model. It should be noted that the only element of the MICL affected by the number of support elements provided is the W. The other element of downtime H is attacked by devising improved support system plans and by obtaining increased weapon system reliability.

MINUTEMAN MICL COST OPTIMIZATION

- **OBJECTIVE:** TO SUPPORT THE WING IN A MANNER WHICH MINIMIZES THE COST PER OPERATIONAL MISSILE

- $R = \dfrac{\text{TOTAL COST OF THE WING}}{\text{NUMBER OF OPERATIONAL MISSILES}} = \dfrac{C_T + N_K C_K}{150\left[\dfrac{M}{M+W+H}\right]}$



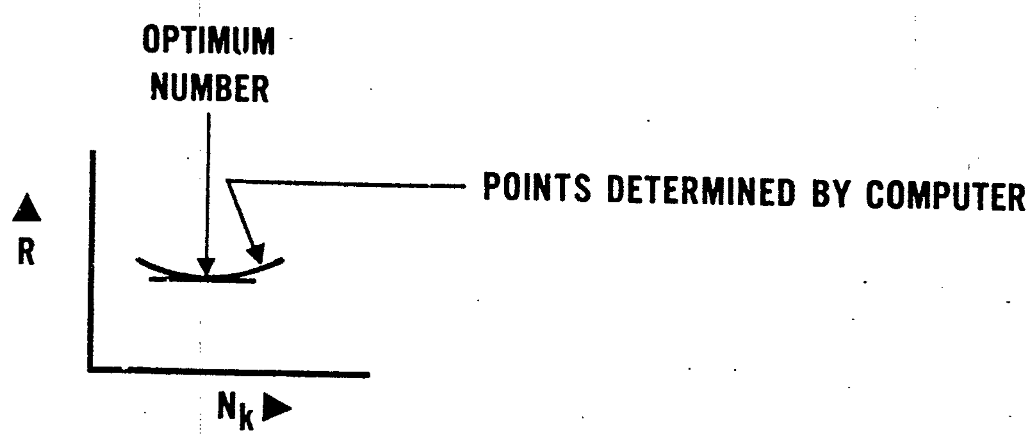


EXHIBIT NO. 14

MINUTEMAN MICL COST OPTIMIZATION

As pointed out in Exhibit #6 and its accompanying text, the objective of the M^2 C/E provisioning model is the calculation of the number of support elements required to derive an optimum balance between support element costs and weapon system downtime costs caused by queuing. Another means of expressing this objective is shown on Exhibit #14 as the ratio R. Since the Wing contains 150 launch facilities,* the R's MICL ratio is multiplied by 150 to convert it to a Wing basis. This denominator then represents the Wing's total effectiveness. The numerator represents the Wing's total cost. C_T represents the total 10-year investment and operating cost of the Wing except for the costs of the support element being studied for optimization. This later cost is represented by $N_K C_K$ where N_K is the quantity provisioned and C_K is the support element K's unit 10-year cost.

In order to find the quantity of the support element being studied which will yield an optimum cost effectiveness ratio R, it is necessary to vary the quantity N in the ratio until this optimum point is found. When N is varied, both the ratio's numerator and denominator are affected since N is also a part of the complex mathematical expression for W. Because of the difficulty and excessive time that would be involved in manually performing the iteration calculations when varying N in increments of one, the equation for R was programmed on a large digital computer to find the value of N which yielded the lowest value for R.

* This is the number in Wings I through IV. Wing V has 200 and that number is used in the ratio R for that Wing.

MINUTEMAN C/E PROVISIONING CURVES

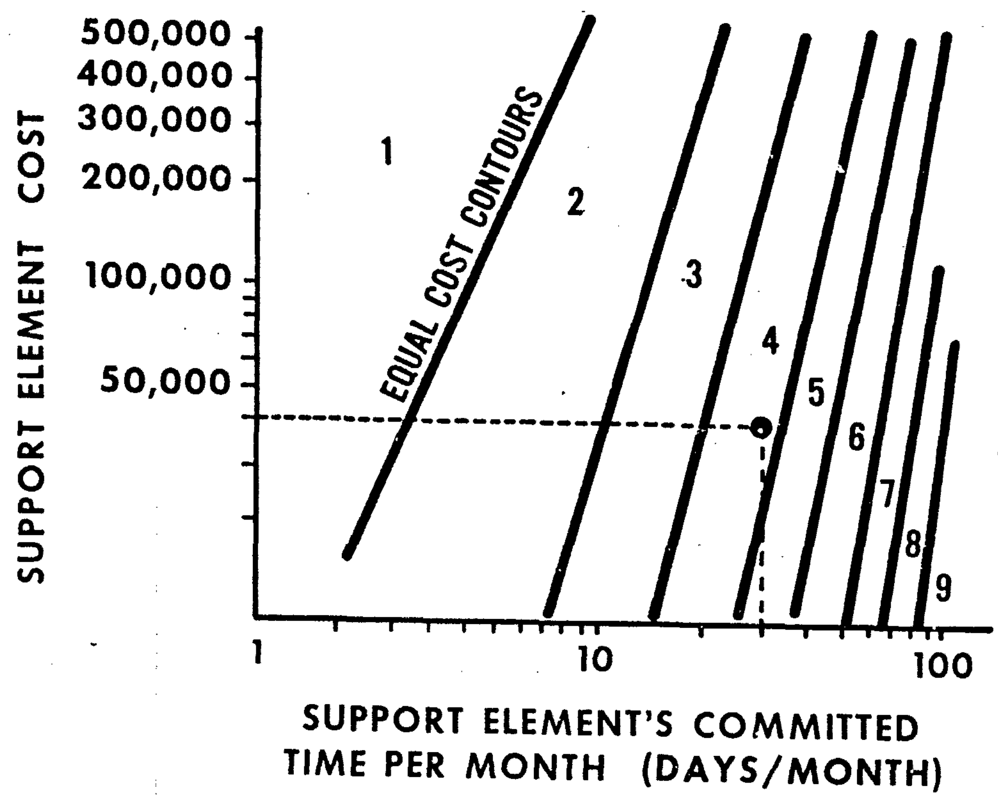


EXHIBIT NO.15

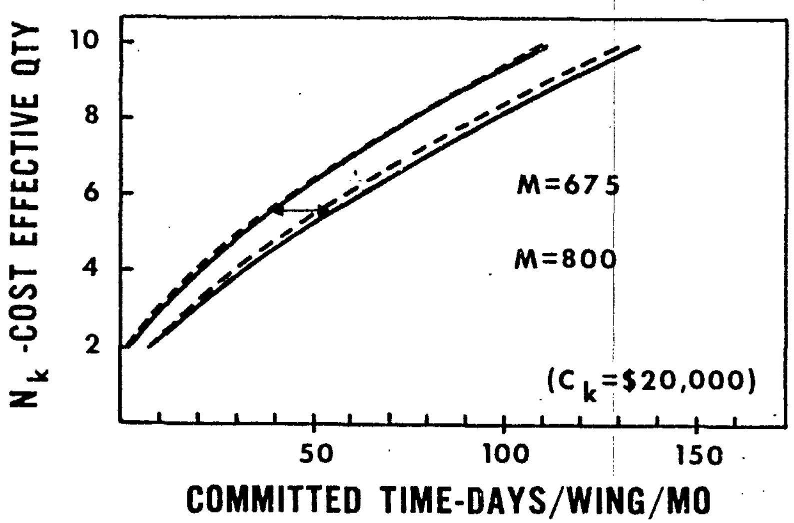
MINUTEMAN C/E PROVISIONING CURVES

The use of the electronic computer permitted the ready determination of the value of N_K which satisfied the criterion of a minimized value of R. Computer runs were made for each of the different support elements under consideration. The computer outputs were then used to plot a family of M^2 C/E provisioning curves. Exhibit #15 is a sample plot. The vertical axis represents the 10-year unit cost of a given support element and the horizontal axis represents the amount of time per month that the support element is required for response to weapon system failures at the Wing in question. This time is called the support element's committed time per month. The family of lines plotted are the equal cost contours for the Wing. These lines include all the points where the cost of one additional support element equals the incremental reduction in downtime cost made possible by the adding of the support element. In the area between any two lines, the incremental cost of the plotted quantity of support elements is less than the equivalent incremental cost of the downtime expected with the plotted quantity of support elements.

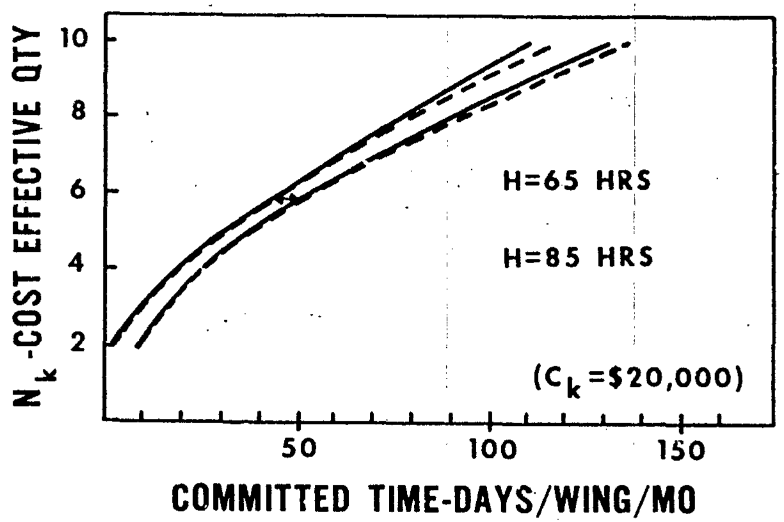
These M^2 C/E provisioning curves are supplied to provisioning personnel who use them for quantifying the various support elements used in repairing no-go failures of M^2 sites. These support elements include all the spares and ground support equipment (maintenance vans, their associated repair crews, test sets, tools, handling equipment, etc.). These curves provide support management with an objective provisioning tool. The need for subjective judgments is essentially eliminated. An example of how the provisioner uses these curves is shown as Exhibit #15. In the

case shown, the 10-year unit cost of the support element is $40,000 and its committed time per month is 30 days. Entering the plot at these points, he finds the point of intersection. In the case shown, this intersection point falls between the equal cost contours defining the area where four support elements are the optimum quantity for these values of support element cost and committed time.

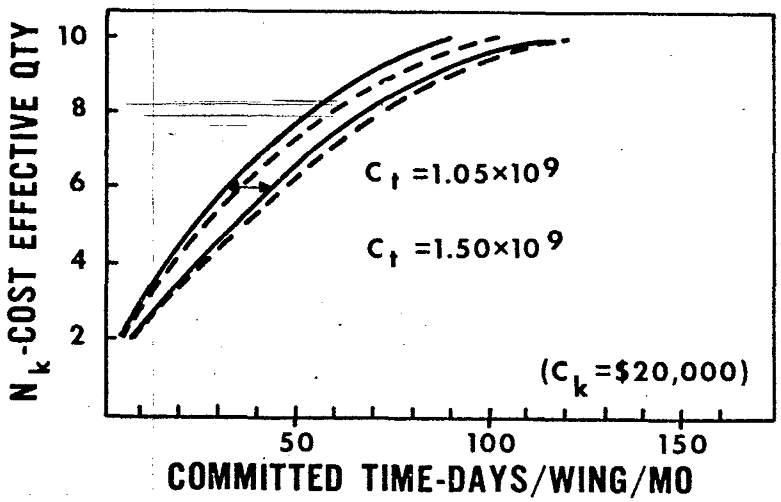
SENSITIVITY OF PROVISIONING QUANTITIES TO M^2 MODEL PARAMETERS



M SENSITIVITY



H SENSITIVITY



C_t SENSITIVITY

EXHIBIT NO.16

SENSITIVITY OF PROVISIONING QUANTITIES TO MODEL M^2 PARAMETERS

In analyzing the M^2 C/E provisioning model, one of the key points of interest to IMI was the relative sensitivity of the model to possible errors in the model parameters. In order to establish the sensitivity to errors in R (see Exhibit #14) of the model's optimum provisioning quantity outputs, it was necessary to make computer runs using various values of M, H and C. Sample plots of these computer runs are portrayed on Exhibit #16. In loading the computer, a 10-year unit cost (C_K) of $20.000 was used. This is an average cost for the M^2 electronic drawer spares. The high degree of the plotted curves' coincidence reveals that the optimum provisioning quantity is relatively insensitive to shifts in the values of M, H and C_T. The magnitude of the errors used in the test are much greater than any expected in the M^2 applications of the model. This reassuring condition is further complemented by the wide error latitude that can be generally tolerated in estimating the support element's unit cost and committed time.

The relative insensitivity to error of the optimum provisioning quantity is a strength rather than a weakness. The primary condition contributing to the tolerable error latitude is the fact that support elements must be procured in whole increments. For example, an error may produce a calculation calling for a quantity of 3.4 support elements, whereas the correct amount is 3.8 support elements (refer to Exhibit #15). In both cases four support elements would be procured since it is not possible to buy less than a whole support element.

MINUTEMAN SUPPORT SYSTEM SIMULATION

- WHAT IS IT ?
  - A COMPUTER LOGIC NETWORK REPRESENTING THE SUPPORT SYSTEM
  - GENERATES EQUIPMENT FAILURES IN RANDOM MANNER
  - SIMULATES REPAIR ACTIONS CALLED FOR BY SUPPORT PLAN
  - TABULATES PERTINENT OUTPUT DATA DESIRED (MICL, QUEUES, ETC.)
- HOW SHOULD IT BE USED ?
  - TO COMPLEMENT DETAILED ANALYTICAL TECHNIQUES
  - TO CORRELATE NON-LINEAR OR COMPLEX INTERACTING FACTORS
  - TO EVALUATE EFFECTS OF GROSS SUPPORT SYSTEM CHANGES
- CONCLUSION :

  CURRENTLY APPLICABLE SIMULATION TECHNIQUES ARE NOT SATISFACTORY FOR DETERMINING THE OPTIMUM C/E PROVISIONING QUANTITIES FOR SUPPORT SYSTEM ELEMENTS.

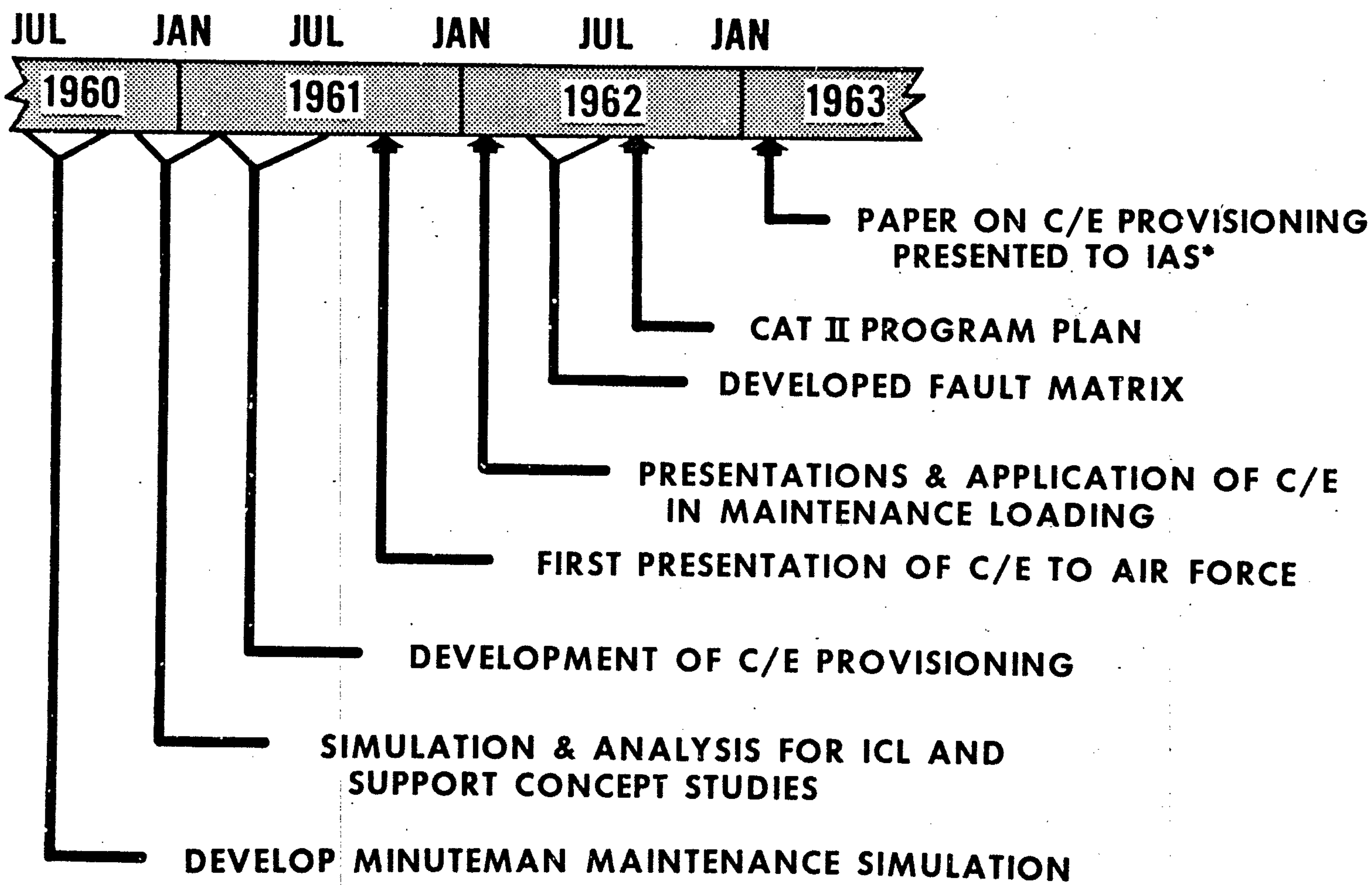
EXHIBIT NO. 17

MINUTEMAN SUPPORT SYSTEM SIMULATION

Computer simulation techniques (war gaming, management and inventory control systems, design, etc.) are of great value to management planners. Erroneous ideas are, however, rather widely held as to what they can do and how they should be applied. This was found to be the case with respect to weapon support system simulation. For instance, at one time it was rather generally believed that such simulation techniques could be used to select the optimum C/E support element provisioning quantities. This did not prove to be the case on the Minuteman Program. The primary reason for this condition is that as an optimum state was approached, it was not possible to discern the relative effect of random failure conditions from those of varying support element quantities.

Although it is not believed that current support system simulation techniques are satisfactory for deriving optimized C/E provisioning quantities, the techniques can be of tremendous value in generating and refining the gross support system concepts and plans. Their use for these latter purposes should be greatly expanded in order to take advantage of their cost saving potential with respect to the elimination of less than optimum support systems while they are still in their paper-planning phases.

CHRONOLOGY OF M^2 C/E PROVISIONING MODEL DEVELOPMENT & APPLICATION



* 31'ST ANNUAL MEETING OF THE INSTITUTE OF AEROSPACE SCIENCES

EXHIBIT NO.18

CHRONOLOGY OF M^2 C/E PROVISIONING MODEL DEVELOPMENT & APPLICATION

The development of the M^2 C/E provisioning model was not an expensive process. Boeing's development and refinement of the technique for application to all five M^2 "A" program Wings required approximately 22 man-months, of which 16 man-months were in its application to Wing I. In consideration of its value, the investment is very small. The principal factors contributing to this minimal cost were the ingenuity of Boeing's model developers and the fact that maximum use was made of the outputs of other weapon system analyses (reliability and failure rate studies, detailed maintenance job time requirements, etc.). Exhibit #18 portrays the highlights of the model's development and application process.

In January of this year, the Rand Corporation published a report* covering their efforts directed to the development of a possible M^2 C/E provisioning model. Rand's approach was carefully analyzed and found to differ only in detail from the approach already developed and applied by Boeing. The optimum C/E provisioning quantities yielded by both models are the same for all practical purposes.

* Rand Memorandum #3308-PR, dated January 1963, titled "Determining Economic Quantities of Maintenance Resources: A Minuteman Application," C. F. Bell and M. Kamins.

M^2 FAULT MATRIX EXCERPT

ELECTRONIC DRAWER	DRAWER FAILURE RATE	FAULT INDICATION CHANNELS												
		28	30	31A	31B	32A	32C	33B	IVA	V	IX	XIV		
MONITOR UNIT	9.72						4.19				3.56			
LINE SELECTOR	6.63	1.38			.15			2.30	.34	.05	1.62			
CONVERTER WAVE FORM	5.97				.32	.07					.63	.34	1.68	
DECODER	6.84		4.82								.06	1.73		
POWER SUPPLY	3.63			3.63										
TOTAL MONTHLY CHANNEL INDICATIONS		1.64	4.82	3.63	.54	.67	6.47	2.30	7.50	.05	12.67	6.99	2.43	

LINE SELECTOR DRAWER

- FAILURE RATE = 6.63 FAILURES/WING/MONTH
- DEMAND RATE = 24.70 DEMANDS/WING/MONTH

POWER SUPPLY DRAWER

- FAILURE RATE = 3.63 FAILURES/WING/MONTH
- DEMAND RATE = 3.63 DEMANDS/WING/MONTH

EXHIBIT NO.19

M^2 FAULT INDICATING MATRICES

Since the M^2 launch facilities (LF's) are unmanned sites, a remote fault indicating system was incorporated into the M^2 weapon system to alert the LF's monitoring launch control center (LCC) to LF failures. This remote LF failure indicating system is commonly referred to as the VRSA system.* VRSA is used to monitor the weapon system's readiness (strategic alert) status as well as to assist maintenance management in making day-to-day plans and decisions regarding the dispatch of repair crews. The following ~~paragraphs contain~~ an explanation of how VRSA ties in with these repair actions and support element provisioning decisions.

Ideally, before responding to an M^2 site failure, the dispatcher would know exactly, which of a site's replaceable modules (an electronic drawer, cable, etc.) has failed. A remote fault indicating system that would make the attainment of this ideal maintenance management situation a reality would be exceedingly complex and expensive. In consonance with C/E support system planning, a compromise was made with this ideal. As a result, a certain degree of fault indication ambiguity exists in the actual M^2 VRSA systems.

In designing the VRSA system, each of the M^2 weapon system's numerous functional circuits was analyzed in detail down to its basic logic level (each electrical gate and flip-flop, amplifier and power supply circuits, etc.). These complex systems

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* A comprehensive description of this VRSA (pronounced "VERSAH") is contained in LMI's 26 March 1963 report, titled "Minuteman Initial Support Study." This report is classified "SECRET."

analyses were required in order to determine how the failures at each logic level could be most economically and practically discerned at the LCC's. In the resulting remote fault indicating system there are some 136 plus fault indicators available at the LCC that can be used to indicate the numerous possible faults that can be expected. Boeing systems engineers designed fault indicating matrices which used all of the available VRSA channels. These 136 plus channels are plotted on the horizontal axis of the matrix and the support systems modular spares and ground support equipment form the vertical axis of the matrix. The body of each matrix contains approved Air Force failure rate data to indicate the total failure rate frequency of each of the support elements and the frequency with which the failures will occur in each of the VRSA channels. The apportionment of the total failure rates among the channels was based upon rigorous reliability disciplines.

Separate sets of the fault indicating matrices were made for support system spares and support equipment. The M^2 matrices are very detailed and require closely typed sheets approximately 8 feet long to cover all the available fault indicating channels. Since the documents are too long to be included as report exhibits, their form and application are demonstrated in Exhibit #19 by the use of a simplified version of a spares matrix.

Reference to the second line on the matrix indicates that the line selector has a predicted total failure rate of 6.63 times per month for the Wing involved, and how that total is apportioned among the fault indicating channels. By using Channel 33B as an example, the way in which these data are applied will be reviewed. When Channel 33B's panel light comes on in an LCC, the matrix provides a means to tell

which spares to dispatch to the failed LF site. In this specific case the failure will always involve the line selector drawer (2.30 times per month total). Accordingly, the maintenance chief will know that a line selector drawer spare and its associated repair personnel and support equipment are the only support elements that need to be dispatched when Channel 33B lights up. Channel IV A provides a contrast to this very simple case.

Exhibit #19 reveals that Channel IV A is predicted to light up 7.50 times per month in total and that this will be caused by a line selector drawer's failure only 0.34 times. The remaining 7.16 fault indications are expected to be the result of failures in other weapon system equipment. In view of these conditions, a cost effectiveness decision must be made as to how often a spare line selector drawer should be taken to a failed site when Channel IV A lights up. In short, a cost trade must be made between the costs of taking and not taking this particular drawer to the site. If a spare line selector drawer is taken for each Channel IV A indication, a large number of these spare drawers must be procured for the Wing. On the other hand, if it is not taken each time, an occasional second repair dispatch from the remote support base will be required when the site's repair crew finds that the Channel IV A indication is in fact due to a failed line selector drawer. A systematic cost trade-off analysis must be made in which the costs of additional drawers are traded off against the costs of a second dispatch and the increased weapon system downtime cost associated with waiting for a drawer to arrive at the site.

The indicated total monthly demand rate for the line selector drawer, which is the number of times that the drawer would be required if it were carried in response

to the total number of times during a month that the fault channels monitoring this drawer's status are expected to light up, is 24.70 times.* In contrast, the total number of actual monthly demands is only 6.63. By using the C/E provisioning curves in parallel with the outputs of a series of simple cost trade-off calculations, the most C/E number of drawers to procure for failure coverage is determined.

The line selector drawer portrayed is an extreme case. The power supply drawer is at the other end of the spectrum. Its monthly failure rate is 3.63 and its total indicated monthly demand rate is also 3.63. Actual M^2 support elements (spares, support equipment and repair personnel) cover the whole spectrum. On the series of spares and support equipment matrices supplied to M^2 provisioning and support personnel, the support elements that should always be taken in response to a particular fault channel control panel indication are circled to distinguish those elements which should be dispatched to the site by second trips. In other words, the C/E trade-off studies have been performed prior to giving the matrices to their users.

In considering the described matrices, it should be borne in mind that they are required solely because of the ambiguities of the weapon system's remote failure indicating system (VRSA). Matrices would not be required for a manned weapon system where fault isolation operations can be performed or for a weapon with a remote fault indicating system which is exact.

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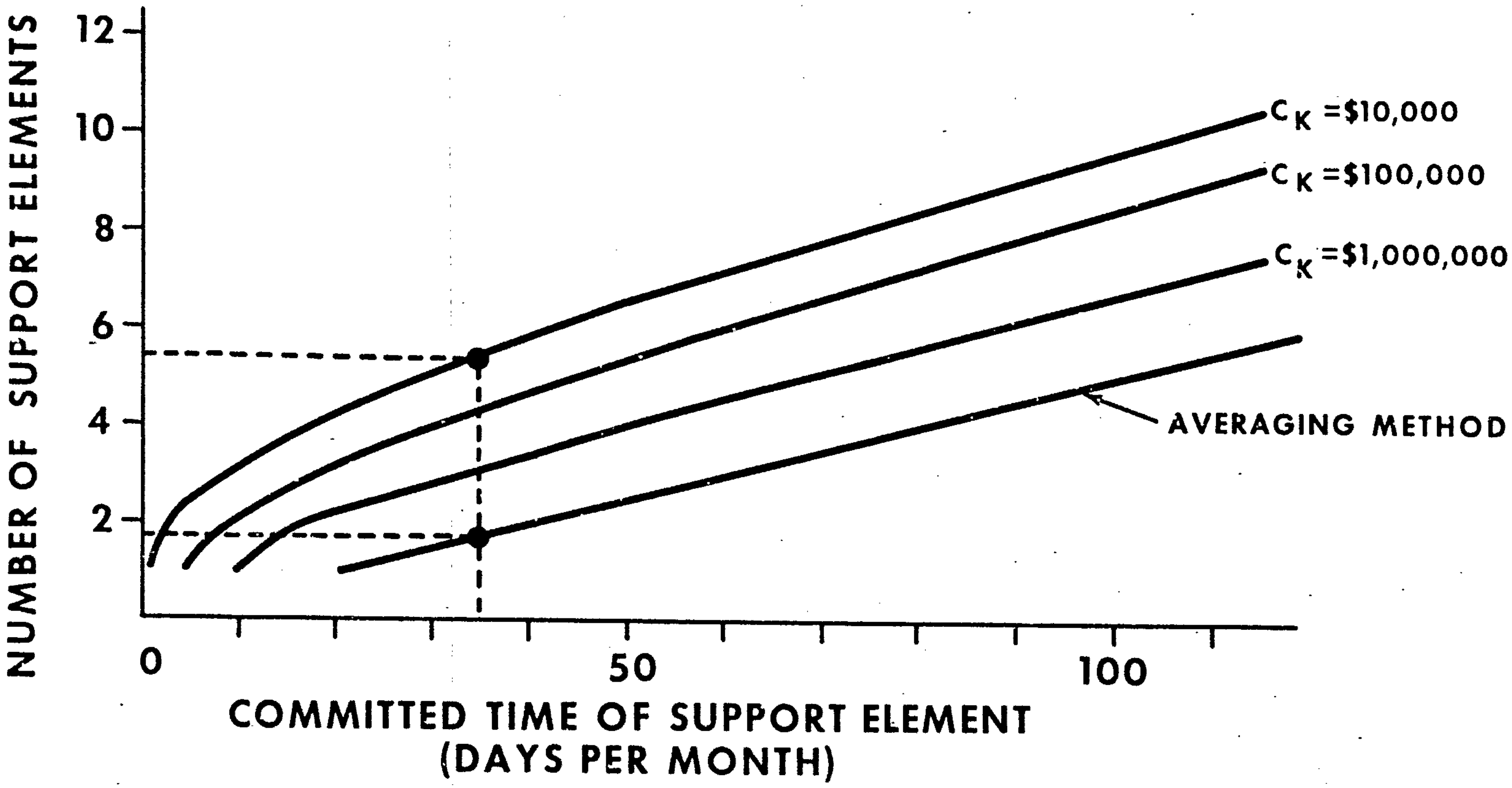
* This total demand rate of 24.70 is obtained by adding up the total monthly indications of Channels 28, 31B, 33B, IV A, V and IX.

C/E vs. AVERAGE DEMAND PROVISIONING QUANTITIES



C_K= UNIT COST OF SUPPORT ELEMENT

EXHIBIT NO.20

C/E VERSUS AVERAGE DEMAND PROVISIONING QUANTITIES

Exhibit #20 is an illustrative comparison of the support elements that would be provisioned using C/E methods and averaging methods. In the case portrayed, where the support elements committed time is 35 days per month and its unit cost is $10,000, a quantity of 6 would be provisioned by the C/E method whereas only 2 would be provisioned using averaging calculations. For the reasons depicted on Exhibit #11, "Minuteman Support Cost Optimization," the C/E provisioned quantity of 6 is coincident with the point of minimum total cost, whereas the averaging quantity of 2 provisioned units would result in excessive weapon system downtime costs due to queueing.

The basic reasons for the differences in the provisioning quantities called for by the C/E and averaging methods are that the averaging methods do not consider queueing or the cost interrelationship that exists between support element quantities and weapon system downtime.*

Exhibit #20 also illustrates why a support system should be considered as a package rather than in terms of its individual elements (see Exhibit #2).

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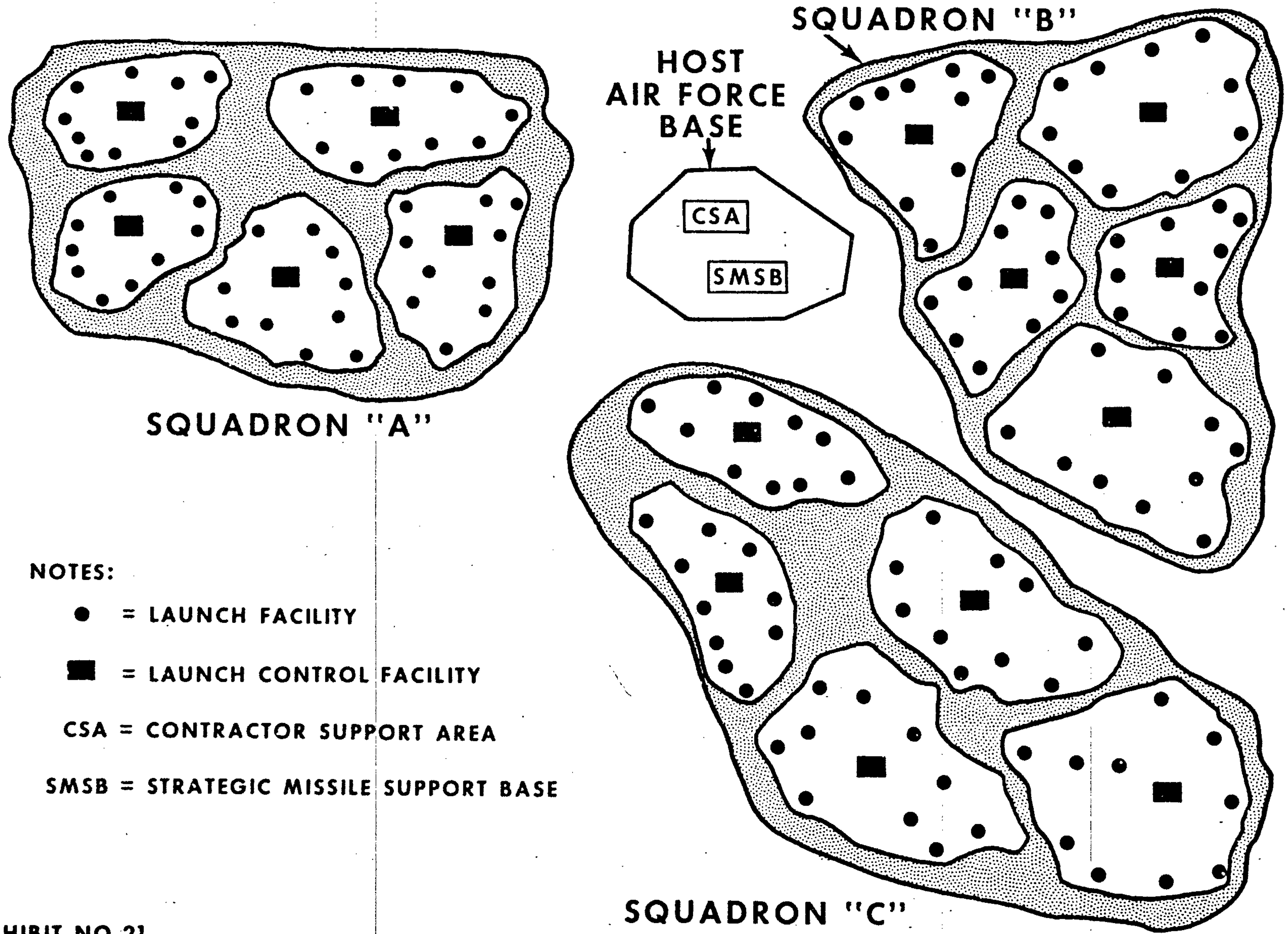
* These points were developed in the text accompanying Exhibits #9, #10 and #11.

C. KEY FEATURES OF THE M^2 SUPPORT SYSTEM

SCHEMATIC LAYOUT OF A M^2 WING



NOTES:

● = LAUNCH FACILITY

■ = LAUNCH CONTROL FACILITY

CSA = CONTRACTOR SUPPORT AREA

SMSB = STRATEGIC MISSILE SUPPORT BASE

EXHIBIT NO. 21

SCHEMATIC LAYOUT OF A M^2 WING

During the course of its study of the M^2 C/E provisioning technique at Boeing's Seattle facilities, LMI developed a series of initial support recommendations which are reviewed in the remaining part of this report. To facilitate an evaluation of those recommendations that are specifically directed to the support system for M^2 Wings, a brief review is provided of a Wing's schematic layout and its support plan.*

As shown on Exhibit #21, the Wing consists of three squadrons, each of which contains five M^2 flights. In turn, each of these flights consists of a launch control facility (LCF) and ten launch facilities (LF's). These operational sites are scattered over an extensive area in the vicinity of the host Air Force base. In addition, the unmanned LF's are remotely scattered around their assigned LCF. When a failure occurs in one of the LF's, the VRSA system indicates the nature of the failure on the LF's launch control center (LCC) panels. In turn, LCC personnel immediately advise the host base's strategic missile support personnel of the type of failure that has occurred. The base's maintenance personnel then start planning for the accomplishment of the required repair actions with the aid of matrices similar to those described in the text accompanying Exhibit #19. They then assign the support elements (spares, test sets, maintenance vans, personnel, etc.) required to accomplish the repair. This action is followed by the outfitting of the required maintenance vans with the support elements which are called for by the repair matrices and instructions. This done, the repair facilities are dispatched to the failed site.

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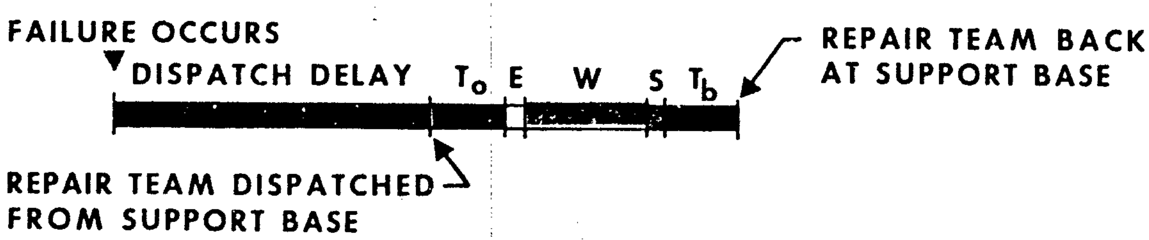
* A detailed review of the Minuteman support system is contained in LMI's 22 March 1963 report titled "Minuteman Initial Support Study." This report is classified "SECRET."

SUPPORT PLAN FOR M^2 WINGS

- PLANNING GUIDE LINES
  - REMOTE FAULT INDICATION SYSTEM (VRSA)
  - REMOVE AND REPLACE REPAIRS PERFORMED BY MOBILE REPAIR TEAMS
  - REPAIR TEAM DISPATCHED AT 0800
  - 12 HOUR MAXIMUM WORKDAY FOR MOBILE REPAIR TEAMS
  - OVERNIGHT TEAM LAYOVERS AT LOCAL LCF FOR REPAIRS TAKING MORE THAN ONE DAY

- ONE DAY TRIP:



- TWO DAY TRIP:

EXHIBIT NO. 22

SUPPORT PLAN FOR THE M^2 WINGS

Exhibit #22 portrays the highlights of the support plan for the M^2 Wings. A few comments follow with respect to the information shown.

(1) Remote Fault Indication System (VRSA) - This system was reviewed in the textual material accompanying Exhibit #19.

(2) Remove and Replace Repairs Performed by Mobile Repair Teams - Failures which occur at the LCF's and LF's are repaired by repair teams which are dispatched from the host base's support area. The repairs are accomplished by the teams by the replacement of the failed modules. This practice is commonly referred to as the "remove and replace" repair concept. In other words, rather than repairing the failed module at the site, it is replaced with a spare module and the failed unit is returned to the support base where the necessary repair operations are planned.

(3) Repair Teams Dispatched at 0800 - The support plan upon which M^2 support elements provisioning is based is that of their being dispatched from the support base only once per day, at 0800. Under this concept, if a failure occurs after 0800 in the day, the failure's required support elements are dispatched to the failed site at 0800 on the following day. This plan results in an average delay of 12 hours between the time a failure occurs and the point at which the required support elements are dispatched. This time delay is generally called the "Dispatch Delay."

(4) 12-Hour Maximum Work Day for Mobile Repair Teams - The M^2 support plan specifies a 12-hour maximum work day for the mobile teams who are dispatched from

the support area to failed sites. A review of the bar chart noted on Exhibit #22 as "One-Day Trip" will clarify how this workday is predetermined by repair planners. All of the time elements shown are backed by a detailed maintenance analysis that has been performed for each of the Wing sites. The results of these analyses are contained in the repair planners' supplied data.

T_O = The time allowance for the repair teams to travel from the support base to the failed site.

E = The time allowance for the repair teams to penetrate the failed site's security system and enter the failed site.

W = The time allowance for the performance of the repair actions called for by the specific failure indication responded to by the team. As depicted here, it includes a lunch-time allowance.

S = The time allowance for the repair team to resecure the repaired site's security system.

T_B = The time allowance for the repair teams to travel from the repaired site back to the support base.

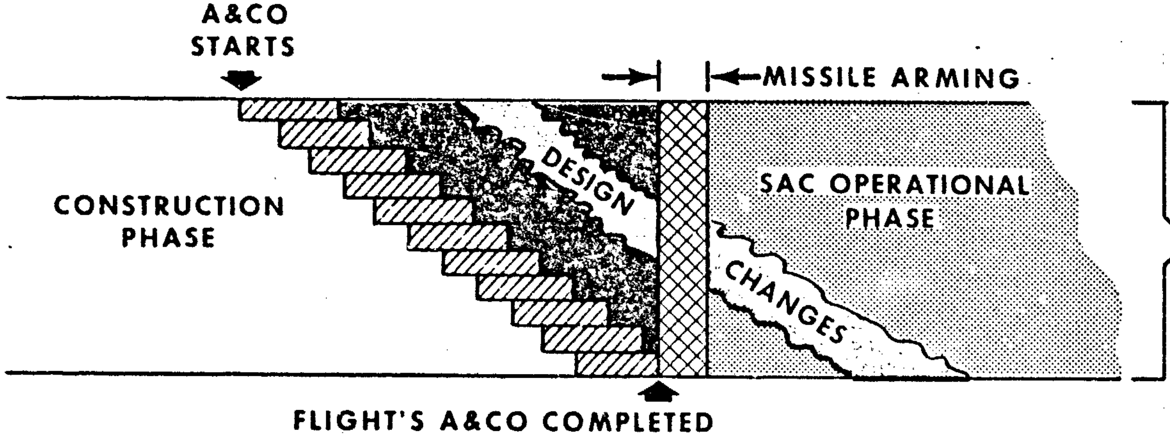
The current M^2 support plan specifies that when the total T_O, E, W, S and T_B exceeds 12 hours, the repair job will be split into more than one day.

(5) <u>Overnight Team Layovers at Local LCF for Repairs Taking More Than One Day</u> - As explained above, when T_O, E, W, S and T_B exceed 12 hours, a second workday is called for by the M^2 support plan. The schematic bar graph of a two-day trip shows how such a repair job is broken down into its major elements by the repair planners.

The elements of T_O, E, W, S and T_B on this chart have the same meaning as for the one-day trip bar chart. In the case of the two-day trip, the planners would divide the job up so that the sum of T_O, E, W, S and the time required for the team to travel to the LF's LCF would be 12 hours (this latter time element is shown as T_L on Exhibit #22). The planning then calls for a 12-hour rest period at the LCF. This time allowance is referred to as the layover time. At 0800 of the second day, the T_L time allowance is again added in the planning to account for the team's travel from the LCF to the failed site. The team then re-enters the failed site (E) and completes the repair work called for (W). After resecuring the repaired site (S), the team travels back to its support base.

If the time elements shown on the two-day trip's bar exceed 24 hours, similar planning elements would be allowed for an additional layover, etc. A review of a longer repair trip's time allowance would serve no purpose here and is therefore not shown.

M^2 ACTIVATION PHASE SUPPORT PLANNING



DEPICTS THE ACTIVATION OF ONE M^2 FLIGHT WHICH CONSISTS OF ONE LCE COMPLEX AND TEN LF SITES

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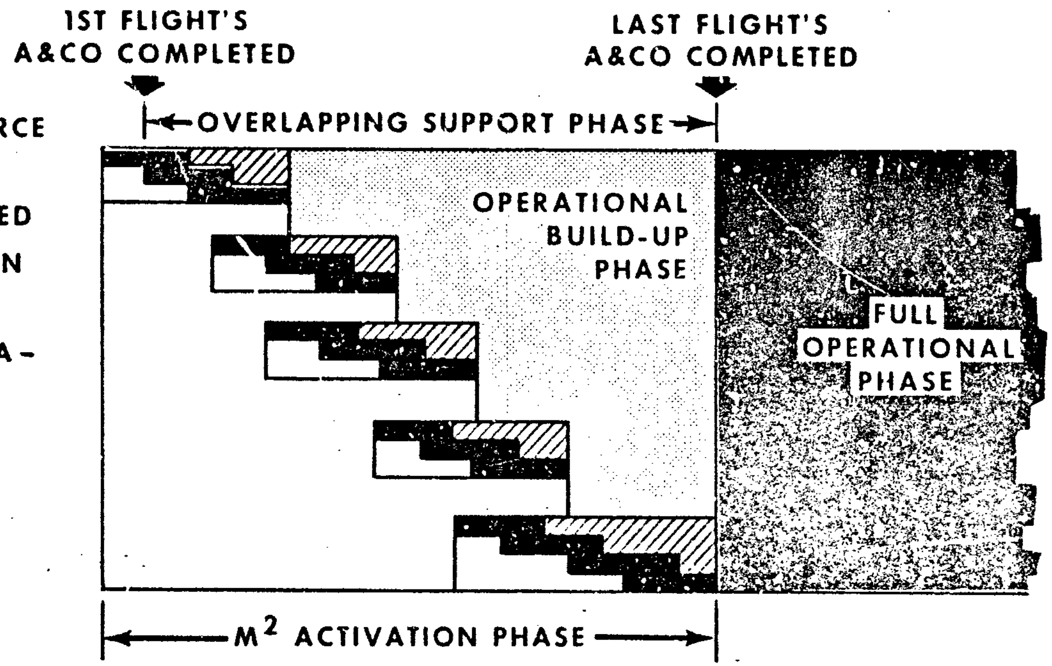

CONDITIONS:

- OVERLAPPING CONTRACTOR & AIR FORCE SUPPORT PERIOD
- DESIGN CHANGES BEING INCORPORATED
- LOGISTICS FAILURE RATES HIGHER THAN DESIGN FAILURE RATES
- TYPICAL SUPPORT SYSTEM IMPLEMENTATION PROBLEMS

EXHIBIT NO. 23

M^2 ACTIVATION PHASE SUPPORT PLANNING

A general understanding of the major aspects of the M^2 program's activation is needed as a basis for evaluating the first project recommendations summarized in subsequent text. Exhibit #23 is a schematic representation of the major steps involved. Since SAC accepts the M^2 weapon system in increments of a complete flight,* a description of the actions involved in activating a flight is provided.

Upon completion of the construction phase of each flight's LCF and LF's, Boeing, in its role as the site activation assembly and checkout (A & CO) contractor, starts installing the various parts of the M^2 system in these LCF's and LF's. As the A & CO operations move along, Boeing personnel perform functional and quality checkout tests of the equipment to assure that they conform to system specifications. Upon Boeing's completion of a flight's A & CO operations, a performance demonstration is made of the flight's operational capability and witnessed by SAC. Upon SAC's acceptance of the demonstrated flight, SAC becomes responsible for its arming, operation and maintenance. Prior to this time, Boeing is responsible for the flight's support.

Under this activation plan, the system's support responsibilities are incrementally phased over from Boeing to SAC and AFLC as the M^2 program's over-all site activation program progresses at the various Wings. This over-all activation program is schematically portrayed at the lower right-hand side of Exhibit #23 where each M^2 Wing is represented as a rectangular block made up of red rectangles which

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* One LCF plus its ten LF's.

represent the Wing's squadrons. Each of these red rectangles depicts the squadron's A & CO phase. As is shown on Exhibit #21, a squadron consists of five flights. Between the point in time when the first M^2 flight is accepted by SAC and the point in time when the last M^2 flight is accepted, separate weapon system support roles are required of Boeing and Air Force personnel. This overlapping support phase, which covers a time span of several years, is portrayed on Exhibit #23.

The support problems requiring skillful resolution during the M^2 program's activation phases are much more complex and critical than those to be contended with after the program reaches its fully operational phase. Support integration problems must be satisfactorily resolved during the program's overlapping support phase if excessive support element residuals are to be avoided upon termination of the activation phase.* Design changes, with their inherent tendency to generate support element obsolescence, are at their peak during the activation period. Equipment failure rates are highly erratic during this period. Personnel training and support system de-bugging problems must also be resolved in the early program phases if their impact on the program's long-term costs are to be minimized. By the time the M^2 program has been fully activated, most of the problems cited in this paragraph will have disappeared. The manner in which they were solved will play a major role in determining the cost effectiveness of the long-range support system.

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* A detailed review of the nature of these problems in the TITAN II and M^2 programs and the actions recommended for their solution are provided in LMI's initial support reports covering these two programs.

SECTION II: RECOMMENDATIONS

A. COST EFFECTIVE SUPPORT TECHNIQUES

M^2 C/E PROVISIONING MODEL RECOMMENDATIONS

- EVALUATE THE BENEFITS OF USING LOGISTICS FAILURE RATE PREDICTIONS IN PLACE OF DESIGN FAILURE RATE PREDICTIONS
- INDUCE GREATER AGREEMENT OF MODEL INPUTS AND ACTUAL PRACTICES AND CONDITIONS
  - DISPATCH DELAYS
  - TRAVEL TIMES
  - SUPPORT ELEMENT REPAIR TIMES
  - ON SITE REPAIR TIMES
  - SUPPORT ELEMENT ATTRITION AND MAINTENANCE COSTS
  - PROCUREMENT COSTS
- DEVELOP AND PROVIDE IMPROVED REPAIR PLANNING AND DISPATCHING AIDS
- EXPAND THE M^2 C/E PROVISIONING TECHNIQUES TO COVER A&CO OPERATIONS

EXHIBIT NO.24

M^2 C/E PROVISIONING MODEL RECOMMENDATIONS

The M^2 C/E provisioning model was designed to identify the number of support elements that would be the optimum C/E quantity for a steady state operational environment. This is the time period depicted on Exhibit #23 as the fully operational phase. In other words, the model assumes that there are no significant differences between the planned support system model parameters and their actual support system values. Since the M^2 program is still in the early phase of its activation program, variances exist between planned and actual values. In recognition of this, the recommendations shown on Exhibit #24 for such things as failure rates, repair times and support element committed times, were developed and presented to the Air Force and Boeing, in a series of briefings which started on 14 June 1963. Brief notes follow with respect to each of these recommendations.

(1) Evaluate the Benefits of Using Logistics Failure Rate Predictions in Place of Design Failure Rate Predictions - For a variety of reasons there is a considerable spread between design failure rates and logistics (actual) failure rates during the M^2 program's activation phase.* The major factors contributing to these differences are:

- The incidence of human errors in equipment operation, use and handling;

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* Exhibit #43 titled "Dynamic Nature of Failure Rates" portrays the differences between design and logistics failure rates.

- The existence of design deficiences which cause higher equipment failure rates than those predicted;

- Higher failure rates caused by errors in specified repair procedures (maintenance manuals and repair technical instructions and orders);

- Higher failure rates caused by quality control problems in the equipment's manufacturing and handling (assembly, testing, transportation, etc.); and

- The secondary failures which occur. These are the failures which are induced in equipments by the failure of some other piece of equipment. They are sometimes referred to as chain reaction failures.

In recognition of the spread in the design and logistics failure rates, it is recommended that a systematic evaluation be made of the feasibility and possible benefits of using predicted logistics failure rates in the C/E model's application. The extensive reliability analysis program that is currently funded and in process should provide an adequate basis for making logistics failure rate predictions when coupled with the formal failure analyses programs being conducted by Boeing and the Air Force. The implementation of this recommendation would serve to fill the gap between the dynamic failure rates actually being experienced and the design failure rates upon which the M^2 C/E model was based and thus would increase the benefits received from this powerful provisioning method.

(2) <u>Induce Greater Agreement of Model Inputs and Actual Practices and Conditions</u> - Until such time as close accord is obtained between actual M^2 support system practices

and conditions and the M^2 C/E provisioning model inputs, the inherent benefits of this new provisioning technique will not be fully realized. The matter of the failure rates used in the model's application was reviewed under Item (1). As noted on Exhibit #24, there are additional model inputs which must be closely monitored if effective provisioning actions are to be taken. In other words, until assumed and actual practices are essentially the same, provisioning actions based upon the model outputs will be questionable. For example, during a trip at Malmstrom Air Force Base (M^2 Wing I), it was learned that the SAC support personnel were not thoroughly aware of the support plan guidelines that had been used as a basis for provisioning support elements.* Conditions of this nature will lead to significant differences between the planned and actual support system practices and results. In recognition of the conditions found, LMI recommended that SAC personnel should play a more active role in the formulation and refinement of the M^2 support system plans so as to achieve greater consonance between plans and actions. Boeing's model developers are keenly aware of the problems that exist in this area but require the assistance of Air Force personnel in order to overcome the problems.

The major elements which LMI believes are in need of increased coordination in order to bring about increased accord between plans and actions are noted on Exhibit #24. Since the matter of failure rates has already been reviewed, the material which follows will be restricted to the remaining elements.

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* As reviewed later in this report under the subject of Resident Support Teams (RST's), communications and coordination problems of this nature can be materially lessened by the application of the recommended RST approach to support management.

- Dispatch Delays - The model assumes an average dispatch delay of 12 hours. In contrast, the conditions depicted on Exhibit #23 have resulted in wide variances from this planning figure. For example, many cases were found where the dispatch delay was more than double the planning value. Greater consonance between the model's dispatch delay allowance and actual requirements must be obtained if correct quantities of provisioned support elements are to be arrived at. It is believed that this consonance can be achieved by obtaining increased SAC participation in support planning functions and by providing SAC with improved repair planning and dispatching aids. The latter point is discussed in the closing paragraphs of this review.

- Travel Times, Support Element Repair Times and On-Site Repair Times - Close monitorship should be exercised here because of the direct impact these elements have on the committed time of support elements. As reviewed in previous text, this is one of the key parameters used in selecting provisioned quantities.

- Support Element Attrition and Maintenance Costs - These costs affect the cost value used in provisioning support elements. It is recommended that special emphasis be placed upon a review of the maintenance vans and vehicles since early indications are that these may have a much shorter life than originally anticipated.

- Procurement Costs - Whereas an appreciable shift in the weapon system's total cost can be assimilated without any significant effect on the C/E provisioned quantity (see Exhibit #16) a review of Exhibit #15 will reveal that shifts in a support element's cost may result in a difference in the C/E quantity if the point of intersection lies close to an equal cost contour. It is therefore recommended that this situation be closely monitored.

(3) <u>Develop and Provide Improved Repair Planning and Dispatching Aids</u> - In recognition of the lengthy time cycles noted at M^2 Wing I for the performance of repair planning and dispatching, it is recommended that improved methods be developed to assist SAC in this critical task. LMI reviewed this matter with Boeing personnel during their joint review of C/E support techniques and agreement was reached as to the desirability and practicality of supplying these aids.

(4) <u>Expand the M^2 C/E Provisioning Techniques to Cover A & CO Operations</u> - Although time did not permit a depth analysis of the recommended action, no serious obstacles to its implementation were discerned by LMI in its preliminary review of the matter with Boeing personnel. It is recommended that the Air Force take immediate steps to make a joint Air Force-Boeing review of this matter.

M^2 MOBILE REPAIR TEAM MANNING

- **FACT**

  CURRENT METHOD DOES NOT USE QUEUEING DISCIPLINES

- **RESULT**

  INCOMPATIBLE SUPPORT SYSTEM PLANNING

- **RECOMMENDATION**

  USE M^2 C/E PROVISIONING TECHNIQUES FOR TEAM MANNING

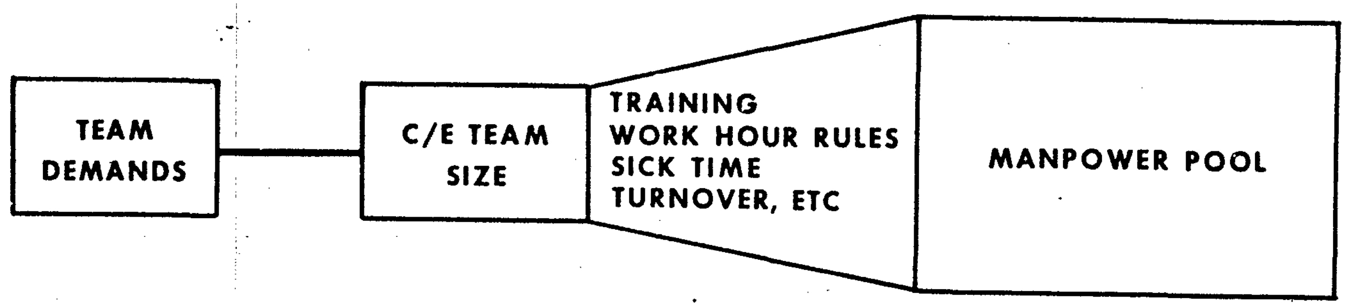


EXHIBIT NO. 25

M^2 MOBILE REPAIR TEAM MANNING

In reviewing the applications of the M^2 C/E model, LMI became aware that full advantage was not being taken of queueing disciplines to establish the size of the M^2 Wing manpower pools required to man the mobile repair teams. The current QQPR1 method is an averaging technique. Since the support elements provisioned for the use of the teams are based upon queueing, an incompatibility exists between support personnel provisioning practices (QQPR1) and the C/E support element provisioning. This situation can be corrected by using the M^2 provisioning techniques to determine the size of repair team manpower pools.

Exhibit #25 provides schematic portrayal of how the C/E model techniques can be applied for M^2 Wing mobile repair team provisioning. The methods currently used to determine the optimum C/E quantity of maintenance vans would also serve to establish the number of team personnel required to man the vehicles. The next step would be to adjust the quantities to account for the amount of time the personnel are not available for work (training, workhour rules, sick time and turnover allowances, etc.) in order to arrive at the optimum size of the Wing manpower pool used to man the teams. An important point that must be considered in provisioning the repair team personnel is that if the same Air Force Skill Code (AFSC) is required on more than one type of repair team (electronics van teams, guidance and contol van teams, etc.), the provisioners must consider this particular skill code as being different for each of the teams. If this is not done an incorrect averaging answer would be derived for the demand rate of this skill code. In other words, it is not possible to provision a single man in increments of less than a whole man.

OPTIMIZED C/E REPAIR CYCLES

- **PRESENT:**
  - CURRENT REPAIR CYCLE TIMES ARE EXPRESSIONS OF TARGETS BASED UPON ESTIMATED CAPABILITIES
- **RECOMMENDED:**
  - USE SYSTEMATIC QUANTITATIVE C/E ANALYSES TECHNIQUES TO DETERMINE OPTIMUM C/E REPAIR CYCLES
- **POTENTIAL SAVINGS:**
  - MULTI-MILLION DOLLAR ANNUAL SAVINGS ON A DoD WIDE BASIS

EXHIBIT NO.26

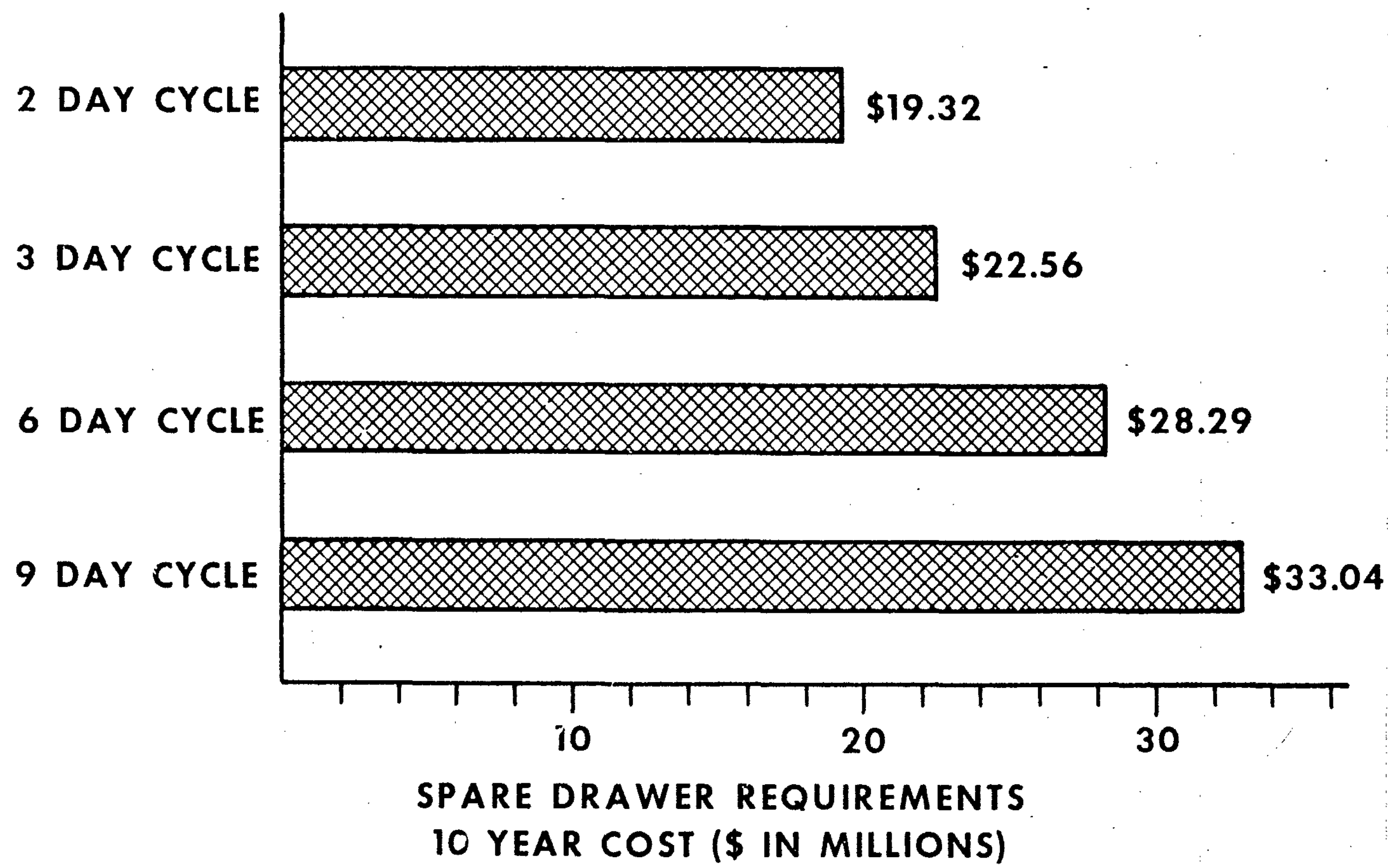
OPTIMIZED C/E REPAIR CYCLES

During the course of performing its various logistics studies, LMI has become increasingly aware of the over-all economies which can be attained through the use of C/E techniques ~~to establish~~ the repair cycle times of support system elements. At the present time repair cycle times used for support system planning purposes are functional (supply, maintenance, etc.) estimates of performance. As indicated on Exhibit #26, it is believed that this approach to repair cycle selection should be abandoned in favor of using C/E analytical techniques. These techniques will reveal the repair cycles that must be established if optimized C/E support postures are to be derived.

In view of the large inherent savings potential it is recommended that the Services take immediate steps to develop and apply the C/E analytical techniques to support system repair cycle planning. In considering this recommendation, the concept of approaching support system planning in terms of integrated packages (Exhibit #2) is a critical one. For example, repair cycle planning may minimize various functional costs while concurrently creating pipeline or weapon system downtime costs which greatly outweigh the economies derived from the repair plans.

BASE REPAIR CYCLE IMPACT ON REQUIRED M 2 ELECTRONIC DRAWER SPARES

(WINGS I THROUGH V)



NOTE: FIGURES SHOWN ARE TOTAL WING I THRU WING V REQUIREMENTS

EXHIBIT NO.27

BASE REPAIR CYCLE IMPACT ON REQUIRED M^2 ELECTRONIC DRAWER SPARES

When repair cycles are discussed, attention is generally focused on the length of depot repair cycles because of the importance of their associated pipeline costs. Small changes in base repair cycles can, however, also have a significant impact on support system costs. An examination of Exhibit #27 helps to illustrate this fact. This exhibit portrays how sensitive the optimum C/E quantity of M^2 electronic drawers is to base level repair cycle changes of only one or two days.

There was a twofold reason for preparing the data reflected on Exhibit #27.

(1) Its primary purpose was to highlight the fact that small changes in base level repair cycles can have a very significant impact on support system costs. As pointed out in reviewing Exhibit #26, analytical C/E trade-off studies should be made to ascertain the most optimum C/E repair cycles as measured in terms of total cost effectiveness.

(2) As pointed out in LMI text covering LMI's M^2 C/E provisioning model recommendations, it is of great importance that consonance is maintained between planned and actual support system repair levels When dealing with this problem at the base level, a few days of unplanned difference in repair cycle time can create excessive weapon system downtime and an unbalanced support system. For example, if a 6-day base level repair cycle should be experienced with respect to M^2 electronic drawers rather than the 3-day cycle used in the M^2 C/E provisioning model, the M^2 support system would have to acquire an additional 5.73 million dollars worth of these drawers in order to maintain an optimum C/E spares posture. The alternative to this additional procurement action would be excessive weapon system downtime costs.

M^2 DEPOT LEVEL REPAIR CYCLES

	REPAIR CYCLE DAYS	
	CURRENT PLAN	POSSIBLE C/E RESULTS
● REMOVE, INSPECT & TURN-IN	2	1 - 2
● PROCESS FOR SHIPMENT	1	0.5 - 1
● IN-TRANSIT TIME	1	1 - 1
● DEPOT PROCESSING TIME	1	0.5 - 1
● DEPOT SCHEDULING	4	0.5 - 1
● SHOP FLOW TIME	15	2 - 5
● RETURN TO DEPOT STOCK	2	0.5 - 1
● TOTAL	26	6 - 12

EXHIBIT NO.28

M^2 DEPOT LEVEL REPAIR CYCLES

A review of the Air Force analysis sheets for Boeing M^2 HI-VALU spares revealed that the majority had a depot repair cycle of approximately 26 days. The HI-VALU elements for this cycle are shown on Exhibit #28 in contrast to a hypothetical case. If actions were taken to reduce the M^2 cycle by the 54% to 77% required to match the repair cycle range of the hypothetical case, a dramatic savings in support element pipeline costs would be made possible. By the same token, any increased support system costs required to attain the shortened cycles would have to be balanced against the gross savings figure to determine whether a more efficient support posture would actually be achieved. In actual cases it would be necessary to perform a series of C/E analyses to determine the value of the most C/E depot repair cycle. Moreover, these analytical techniques would have to be used to evaluate the many possible methods by which a shortened depot repair cycle might be achieved. While the above facts are clear, there are a few that might not be. For example, the hypothetical M^2 repair cycle shown is believed to be attainable with careful planning and adequate repair cycle control discipline. The M^2 HI-VALU cycle represents estimates of functional capabilities rather than a cycle that has been arrived at by C/E analysis. Despite the fact that M^2 HI-VALU depot repair cycles are tight when compared to Air Force averages, there is no assurance that the current cycle plans are the most cost effective.

The use of the M^2 program as a vehicle for this review is not to suggest poor M^2 support system planning. Quite the contrary was found to exist. Similar examples

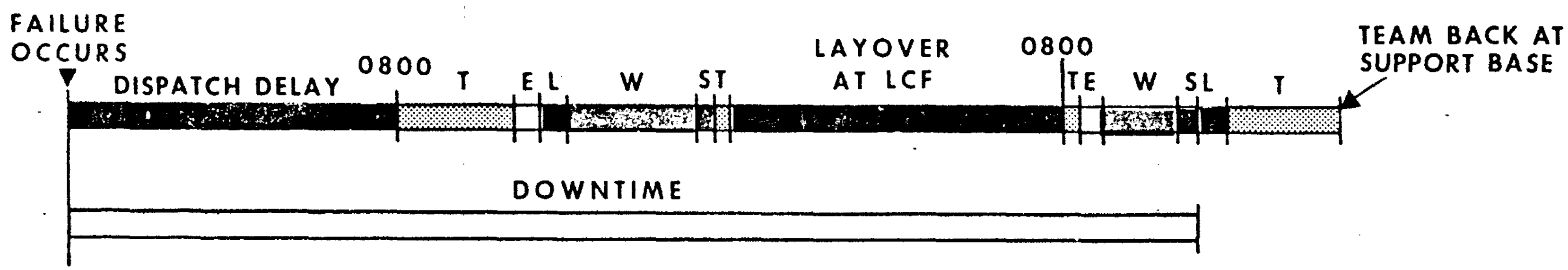
could be cited based upon any major weapon system, regardless of its service location. The sole purpose of reviewing Exhibit #28 is to help illustrate why LMI has recommended that C/E analytical techniques be used to establish repair cycles in all DoD services.

RELIEF M^2 MOBILE REPAIR TEAMS

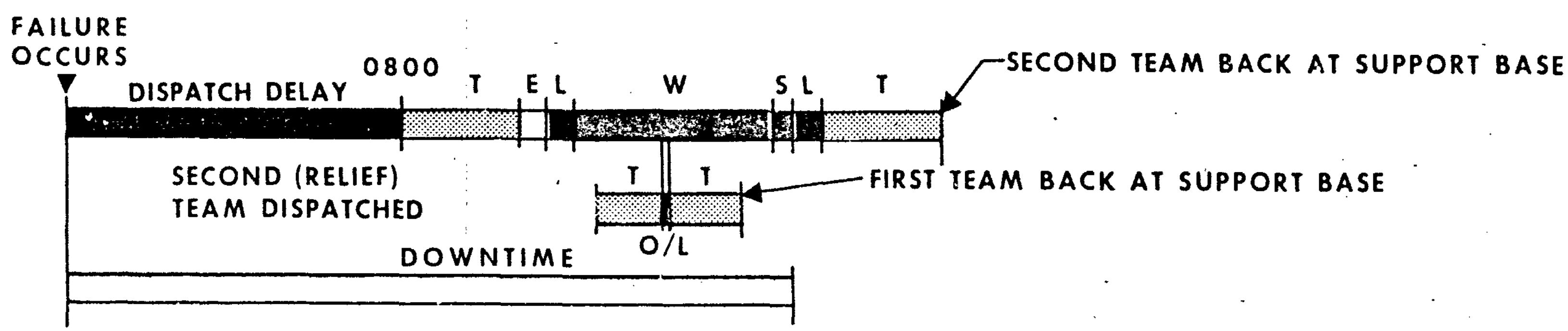
- **CONCEPT:**

  PROVIDE CONTINUOUS REPAIR EFFORT ON SITE FAILURES REQUIRING MORE THAN ONE WORKING DAY

- **PRESENT APPROACH:**



- **RECOMMENDED APPROACH:**



- DOWNTIME REDUCED APPROX 40%
- IMPROVED UTILIZATION OF SUPPORT SYSTEM ELEMENTS
- IMPROVED M^2 MOBILE REPAIR TEAM MORALE

EXHIBIT NO. 29

RELIEF M^2 MOBILE REPAIR TEAMS

Current M^2 site repair planning calls for overnight field layovers of support personnel, equipment, and spares. One of LMI's support system studies involved a C/E evaluation of alternative plans which would simultaneously reduce weapon system downtime and derive more effective utilization of support resources. A number of different plans were considered before making a detailed study of LMI's recommended concept of providing continuous repair effort on site failures of a type which cannot be repaired in one working day. Exhibit #29 compares the current plan with LMI's recommended plan.

The color segmented bars shown for the present M^2 approach represent the time-line requirements of a typical 2-day electronic failure. A few notes follow with respect to the various segments shown on this timeline.

- Dispatch Delay - This is the 12-hour average delay that occurs before responding to site failures by dispatching the required support elements.
- T (Shown in Grey) - This is a travel allowance. Since the symbol was used in four parts, the purpose of the time allowance for each T is given in the sequence in which they appear.

    First "T" = Allowance time for the repair team to travel from the support base to the failed site;

    Second "T" = Allowance time for the repair team to travel from the failed LF site to its LCF for an overnight rest period;

Third "T" = Allowance time for repair team to travel back to the failed site in the morning (the team leaves at 0800 on second day also); and

Fourth "T" = Allowance time for the repair team to travel back from the repaired site to its support base.

- E (Shown in Yellow) - The time allowance for the repair team to penetrate the failed site's security system and enter the failed site. Since two days are involved, this entering process must be repeated on the second day.
- L (Shown in Blue) - The mealtime allowance for the repair team.
- W (Shown in Orange) - The time allowance for the performance of repair actions called for by the specific electronics failure that has occurred.
- S (Shown in Green) - The time allowance for the repair team to resecure the site's security system. This operation must be repeated each time the repair team leaves a site.
- Layover (Shown in Blue) - The time allowance for the repair team to rest overnight at the failed site's LCF.
- Downtime (Shown in Red) - The amount of time that the failed site is in a non-strategic alert status.

A review of LMI's approach follows in four parts. These four parts explain the sequence of planned maintenance events, how they would reduce downtime, how improved utilization of support elements would be made possible, and why mobile team morale should be improved.

(1) Recommended Approach's Timeline - The dispatch delay would not be affected by this method since it would employ a part of the present dispatching logic which

specifies that failures occurring after 0800 will be responded to on the following day at 0800. The remaining parts of the present dispatching logic and repair plan would be changed. When an LCC notifies the support base of an electronic site failure, the support planning personnel can quickly ascertain whether a 1- or 2-day repair trip would be required when using the current M^2 approach by noting its distance from the support base and by using their planning data which specify the specific failure's repair timeline requirements. A detailed analysis revealed that, using the present approach, over 50% of the electronic site failures would require 2-day trips. The recommended approach would allow the repair of electronic failures currently requiring a 2-day trip to be accomplished in one day. This would be made possible by providing a relief (second shift) repair crew so as to allow a continuous repair effort. As schematically portrayed in the recommended approach's timelines*, a relief team would be dispatched to arrive at the failed site approximately one-half hour before the first shift team was scheduled to leave. The recommended approach's timelines show that a team overlap period (noted as O/L) of approximately a half an hour would be provided for the teams at the failed site to assure necessary repair effort continuity. Following the overlap period, the first shift would depart for the support base by personnel vehicle and the second shift would complete the required repair actions and then travel back to the support base in the maintenance vehicles.

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* These timelines represent the times required for a typical electronics failure requiring a 2-day trip under the present support approach.

(2) Reduced Weapon System Downtime - Increased missile in commission benefits to be derived from using the relief team approach would be significant even on the simplest type of M^2 failures (electronic). For example, the present planned downtime would be reduced by approximately 40% as shown on Exhibit #29. Because of their complex nature and spare requirements, timelines are not shown for the M^2 program's more time-consuming guidance and control, missile, or re-entry vehicle failures. All of the various types of M^2 failures were, however, analyzed in considerable detail. The reduction in downtime made possible by the relief team concept would be even more dramatic when the more complex types of failures occur. For example, using the current planning approach, a downstage (missile) failure would involve approximately seven days' downtime as contrasted to approximately three days using the relief team concept.

(3) Improved Utilization of M^2 Support System Elements - As depicted in Exhibit #29's timelines, the M^2 spares and support equipment (maintenance vans, test sets, etc.) required for the repair of failed electronic units would be returned to the support base much sooner when using the relief team concept. For example, the timeline for the present approach shows that the support equipment is committed for the electronic failure for approximately 33 hours, whereas approximately 18 hours would be required using the relief team approach. As in the case of the downtime benefits, the reduction of support element committed times would be much more pronounced for the more complex M^2 site failures (guidance and control package, downstage and warhead failures).

(4) Improved M^2 Repair Team Morale - In addition to the benefits received in terms of reduced weapon system downtime and higher support element utilization, the recommended

approach should serve to improve the morale of mobile team personnel since they would be able to spend more of their evenings at their home quarters with their families.

POTENTIAL BENEFITS OF RELIEF M^2 MOBILE REPAIR TEAM APPROACH

(WS - T33A PROGRAM)

- M^2 MICL TOTAL INCREASED BY 17.8 MISSILES ($125,000,000 10 YEAR VALUE)
- M^2 MOBILE SUPPORT EQUIPMENT REQUIREMENTS DECREASED BY $16,200,000 (10 YEAR COST)
- M^2 SPARES REQUIREMENTS DECREASED BY $2,100,000 (10 YEAR COST)
- IMPROVED M^2 MOBILE REPAIR TEAM MORALE

EXHIBIT NO.30

POTENTIAL BENEFITS OF RELIEF M^2 MOBILE REPAIR TEAM APPROACH

Exhibit #30 provides a summary of the major potential benefits inherent in the recommended relief team concept. The values shown were derived from the study which LMI performed with the assistance of Boeing personnel at their Seattle, Washington facilities.

(1) M^2 MICL Total Would Be Increased by 17.8 Missiles ($125,000,000 ten-year value) - The average missile in commission level (MICL) for Wings I through V would be increased by the use of the relief M^2 mobile repair team approach recommended by LMI. This increase in MICL would be caused primarily by the elimination from the missile downtime period of the mobile team overnight LCF layover periods. The manner in which this would be accomplished is shown on Exhibit #29. The 17.8 MICL increase figure was arrived at by determining the average downtime that would be experienced for each type of no-go failure using the present and recommended approaches. These downtime values for each failure type were then weighted by the frequency of occurence of each different type failure. The ten-year equivalent value (procurement plus operating costs) of the 17.8 M^2 missiles is approximately $125,000,000. This figure does not include R & D or missile warhead costs.

(2) M^2 Mobile Support Equipment Requirements Would Be Decreased by $16,200,000 (ten-year cost) - As pointed out in the text for Exhibit #29, the recommended relief team approach would permit a higher degree of support element utilization than can be obtained with the present M^2 planning approach. The primary reason for this is that these dispatched support elements would be in continuous use under the relief

team concept in contrast to the idle time involved in the layover periods of the present M^2 approach. Since the relief team concept would permit the site failures to be repaired in less total time, the support elements would be returned to the support base sooner and would be available for reapplication on other failure repair missions. In terms of the M^2 C/E provisioning model, the support elements' committed time per failure would be less with the relief team approach. These shortened committed times for the mobile support equipment (maintenance vans, programmer group test sets, coupler test sets, etc.) would result in a support equipment requirement decrease of $16,200,000 total (ten-year cost) for Wings I through V.

(3) <u>M^2 Spares Requirements Would Be Decreased by $2,100,000 (ten-year cost)</u> - The requirement for M^2 spares dispatched to repair site failures would be reduced by $2,100,000 (ten-year cost) using the relief team approach. The reason for this is the same as that reviewed for the reduced support equipment requirement, namely, the reduction in the average committed time requirement per failure response.

(4) <u>Improved M^2 Mobile Repair Team Morale</u> - Since the relief team approach would permit a significant reduction in the required number of overnight field layovers at LCF's, the team personnel would be able to spend a greater percentage of their free time with their families and friends. This is an important consideration. Although no dependable dollar savings can be attributed to this proposed change, there is no doubt but that it would produce measurable increases in personnel efficiency.

RELIEF M^2 MOBILE REPAIR TEAM SUMMARY

IMMEDIATE AIR FORCE ACTION RECOMMENDED

- PERFORM A DETAILED AIR FORCE EVALUATION OF LMI'S RECOMMENDED USE OF RELIEF M^2 MOBILE REPAIR TEAMS

ASSUMPTION

- LMI STUDY CONCLUSIONS WILL BE VERIFIED BY DETAILED AIR FORCE EVALUATION STUDY

RECOMMENDED FOLLOW-THRU ACTIONS

- IMMEDIATE IMPLEMENTATION OF RELIEF M^2 MOBILE REPAIR TEAM APPROACH
- TAKE APPROPRIATE ACTIONS TO CAPITALIZE ON INCREASED MICL CAPABILITY OF 17.8 MISSILES
- REDUCE M^2 SPARES PROCUREMENT BY APPROXIMATELY $1,300,000 (PROCUREMENT COST PORTION OF $2,100,000 10 YEAR SPARES' COSTS)
- RESCHEDULE APPROXIMATELY $6,500,000 OF EXCESS M^2 SUPPORT EQUIPMENT TO AVOID APPROXIMATELY $1,000,000 PER YEAR IN EQUIPMENT MAINTENANCE COSTS

EXHIBIT NO.31

RELIEF M^2 MOBILE REPAIR TEAM SUMMARY

In view of the very significant potential benefits inherent in the relief M^2 mobile repair team approach recommended by LMI, it has been suggested that Air Force personnel perform a detailed evaluation of the plan. Although the relief team study performed by LMI and Boeing was necessarily of a condensed type, a considerable amount of detailed analyses work was accomplished. LMI believes that a more detailed evaluation will verify the major conclusions stated on Exhibit #30. On that assumption the follow-through actions summarized on Exhibit #31 are recommended.

(1) Immediate Implementation of Relief M^2 Mobile Repair Team Approach - In view of the personnel planning details that will be required to implement the relief teams, it is recommended that these details be worked out concurrently with the Air Force/SAC evaluation effort as a means of expediting the total implementation process. Although application of the QQPR1 method would indicate that no additional repair team personnel would be required, LMI believes that some increase will be needed. It is recommended that any personnel adjustment figures be based upon the approach outlined in the report text for Exhibit #25.

(2) Take Approrpriate Actions to Capitalize on Increased MICL Capability of 17.8 Operational M^2 Missiles - The considerations involved in this matter are beyond the scope of LMI's functions.

(3) Reduce M^2 Spares Procurement by Approximately $1,300,000 (procurement cost portion of $2,100,000 ten-year spares' costs) - In order to take economic advantage of the reduced M^2 spares requirements inherent in the M^2 relief team approach, it is

recommended that actions be initiated to reduce the M^2 spares buy program by $1,300,000. The exact spares to be cut are covered in the LMI-Boeing study.

(4) <u>Reschedule Approximately $1,500,000 of Excess M^2 Support Equipment to Avoid Approximately $1,000,000 Per Year in Equipment Maintenance Costs</u> - During the LMI-Boeing study of the relief mobile team approach, it was found that essentially all of the M^2 support equipment for all five Wings had already been procured, thus precluding the procurement cutback that would otherwise have been possible. Sizeable savings can, however, still be made by rescheduling (mothballing or storing depot M^2 as support system backup) approximately $6,500,000 of the excess support equipment that should be generated by the implementation of the relief team approach. This action would eliminate these excess equipments' annual maintenance costs of approximately $1,000,000 per year. As in the case of the spares, the exact items of surplus support equipment expected are identified in the LMI-Boeing study.

Although the advantages of the relief teams are not as large for M^2 Wing VI because 2-day and longer trips will be required less frequently, consideration should also be given to its application to cover Wing VI's guidance and control package, downstage, and re-entry vehicle failures as it is believed that the relief team approach will be advantageous for these time consuming repair efforts.

THREE BASIC REPAIR DECISIONS

(1) THE REPAIR VERSUS THROWAWAY DECISION

IS IT MORE ECONOMICAL TO REPAIR THE ITEM OR TO THROW IT AWAY?

(2) THE REPAIR LEVEL DECISION

WHICH ORGANIZATIONAL LEVEL SHOULD MAKE THE REPAIR?

(3) THE REPAIR SOURCE DECISION

TO WHAT IF ANY DEGREE SHOULD THE REPAIR BE MADE BY A CONTRACTOR?

EXHIBIT NO.32

THREE BASIC REPAIR DECISIONS

Earlier in this report, reviews are made of LMI's general view that C/E analytical techniques should be employed for weapon system support planning. C/E support planning is described and illustrated. Illustrations are also given of its use as a provisioning system, a refined planning tool for support personnel manning, and a means of determining optimum C/E repair cycles. The last series of charts show how C/E techniques can be applied to refine a weapon system's maintenance planning. Additional, more refined, application areas for C/E support system planning techniques are now discussed.

In order to approach an optimum C/E support system posture, three basic and interrelated decisions must be made with respect to repairable* support system elements. The decisions are:

(1) The Repair Versus Throwaway (No Repair or Consumable) Decision - As the term implies, this is the decision which controls whether failed repairable support system elements will be repaired or replaced. It is basically an economic decision. If it is to be made on a C/E basis, cost trade-off studies must be made to determine whether total costs will be less if the item is repaired than they will be if the failed item is thrown away and not replaced with a new item.

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* As the term is used here, "repairable" means that it is physically possible to repair a support system element that has experienced a normal type of failure (a non-catastrophic failure).

(2) The Repair Level Decision - This decision determines the maintenance level at which repair operations will be performed on the failed support system element. For instance, using Air Force terminology, a decision must be made whether any specific repair should be made at the field, base, or depot level. In the case of the M^2 program, the field level would be at an LF or LCF;* the base level is the Wing's support base, and the depot level would be an Air Force AMA or contractor plant. Total cost trade-off analyses must also be made if the optimum decision is to be rendered here.

(3) The Repair Source (In-house Versus Contractor) Decision - Regardless of the repair level, a decision must be rendered with respect to the degree to which Service and contractor personnel will be involved in the repair operations. That is, should the repairs be 100% by contractor personnel, 100% by Service personnel, or with some ratio of each participating.

The cost trade-off studies in each of these areas are complex and challenging. LMI did not develop applied cases illustrating how C/E techniques can be applied to all of the decision areas. A limited depth application was made, however, with respect to the repair level decision on the M^2 program.

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* Already defined.

M^2 DEPOT VERSUS BASE LEVEL REPAIRS

CURRENT METHOD (PLAN A)

- SUPPORT SYSTEM ELEMENT REPAIRS ARE MADE AT EACH WING'S SMSB (STRATEGIC MISSILE SUPPORT BASE).

COST EFFECTIVENESS PROPOSAL (PLAN B)

- REPAIR HIGH COST LOW FAILURE RATE SUPPORT SYSTEM ELEMENTS AT THE DEPOT LEVEL.

BASIC SUPPORT ELEMENT FLOW

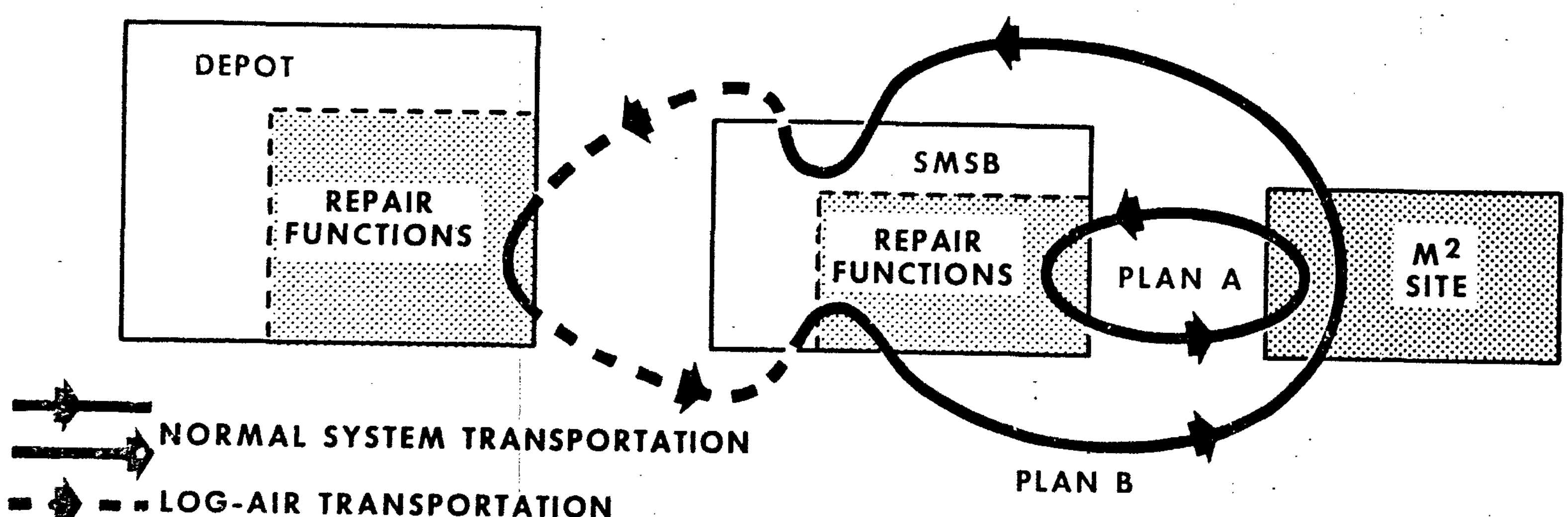

EXHIBIT NO.33

M^2 DEPOT VERSUS BASE LEVEL REPAIRS

In reviewing the details of the current repair plan for the high-cost, low-failure rate M^2 Wing support elements (electronic drawers, test sets, electrical motors, etc.), it was LMI's intuitive judgment that greater C/E advantage could be taken of their high reliability characteristics by having their relatively infrequent repairs made at the depot level rather than at the base (Wing) level. In order to test this judgment, LMI enlisted the aid of Boeing personnel in the performance of a C/E analysis of the current base level repair plan and a depot level repair plan. In the review of the analysis performed by LMI and Boeing, the current plan is referred to as Plan A and the plan recommended by LMI for Air Force evaluation is referred to as Plan B.

Plan A (Current M^2 Plan) - Under the current M^2 Wing provisioning and repair plans, support elements are provisioned on the basis that they will be used only for response to failures that occur within given Wing's boundaries. In other words, their regular use at other Wings is not planned on, and they will only be used at other Wings in cases of rare emergencies.

When a Wing support base (SMSB) receives notification of a no-go site failure, support planners make the necessary arrangements to accumulate the support elements required to dispatch a mobile repair team to the failed site in accordance to the Wing's dispatching and repair system guide rules. In the LMI-Boeing study, these guide rules were identical for Plans A and B.

Under Plan A, each of the five M^2 WS-133 A Wings is provided with the capability to repair approximately 95% of the failures expected to occur in its high-cost,

low-failure rate support elements. The remaining 5% is an allowance for the more complex failure repair actions that will only be called for occasionally. In order to do the repair work at the Wing (base) level, each Wing SMSB requires an extensive inventory of expensive repair facilities. For example, three of the automatic test equipment consoles required in the SMSB have an average unit procurement cost of approximately $310,000. The other pieces of required SMSB repair equipment have unit prices ranging from about $100 to $58,000. In addition, an extensive inventory of high-cost SMSB repair parts must be maintained. For example, the required inventory of electronic cards required for the repair of the Wing's electronic drawers have a unit procurement cost of about $1,000.

The flows of M^2 support system elements for Plans A and B are depicted on Exhibit #33. A few explanatory statements follow with respect to the repair flow lines. Under Plan A, an M^2 site (LF or LCF) failure is responded to by a SMSB dispatch to the failed site of the required support system elements. After the repairs have been completed, the mobile M^2 repair teams transport the failed support system elements to the SMSB for repair. As cited earlier, approximately 95% of the support system element repairs will be made at the SMSB. The remaining 5% are transported to a repair depot by means of a scheduled Log-Air flight which operates on a daily basis.

<u>Plan B (Proposed</u>) - Under this plan the required support elements would be dispatched and returned to the Wing SMSB in a manner identical to that used for Plan A. From there on, however, a different procedure would be called for. All of the failed high-cost, low-failure rate support elements would be trans-shipped to a repair depot

by a scheduled Log-Air flight for the performance of required repair actions. Upon completion of the repairs, the support element would either be stored at the depot or flown to one of the five Wings where it would be placed in the usable support element storage area.

The decision whether the repaired element would be stored at the depot or shipped to one of the five Wings for storage would be based upon the total system inventory of the specific spare and its distribution status at that specific point in time. The decision called for would be the one which resulted in an equal distribution of the available repair elements among the five Wings. For example, if there were ten spares available, the distribution plan would call for two at each of the Wings. If, on the other hand, there were only a total of three spares available, the distribution plan would place one of these spare elements at Wing I, another at Wing IV, with the remaining spare being stored at Wing V. By this means, maximum advantage will be taken of the total spares population and the probability that the failure of their equipment counterparts will occur in a distributed and random fashion.*

Under the proposed Plan B, the current requirement for the current extensive inventory of costly SMSB repair equipment, parts and SAC SMSB repair personnel would be eliminated. The quantitative impact of Plan B on required M^2 support elements is reviewed in the text of the next two exhibits.

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* As a note of interest, this proposed repair and distribution plan is essentially identical to that currently used so effectively to support the costly M^2 guidance and control system elements.

M^2 DEPOT VERSUS BASE LEVEL REPAIR STUDY COST TRADE-OFF SUMMARY

SUPPORT COST ELEMENTS	10 YEAR COSTS ($ IN MILLIONS) DEPOT REPAIR (PLAN B) DECREASES	10 YEAR COSTS ($ IN MILLIONS) BASE REPAIR (PLAN A) ADDITIONS
ELECTRONIC DRAWERS	$10.5	
ELECTRONIC CARDS	2.5	
MOBILE TEST SETS	9.9	
AUTOMATIC TEST EQUIPMENT	15.1	$5.0
REPAIR PERSONNEL	33.1	13.5
LOG-AIR TRANSPORTATION		5.8
WEAPON SYSTEM DOWNTIME		3.9
TOTALS	$71.1	$28.2

GROSS INDICATED SAVINGS = $42,900,000 (10 YEAR BASIS)

ESTIMATED POTENTIAL SAVINGS = $ 34,200,000 (10 YEAR BASIS)

EXHIBIT NO.34

M^2 DEPOT VERSUS BASE LEVEL REPAIR STUDY COST TRADE-OFF SUMMARY

In its series of Air Force briefings, LMI stressed the fact that the C/E study of the M^2 depot versus base level repair plans was necessarily performed within a short time frame. Accordingly, the study compromised with detailed measurements and utilized rounded-off numbers. As a consequence, the costs and savings depicted on Exhibit #34 will change with respect to their details upon performance of a detailed C/E analysis. The exploratory study figures shown on Exhibit #34, however, are believed to be conservative and of the correct order of magnitude. A few explanatory statements follow with respect to Exhibit #34 entries.

(1) Electronic Drawers - The depot repair plan would bring about a higher drawer utilization than that which is practical using the current base level repair plan. The higher utilization factor would reduce the requirement for drawers. The reason for the higher utilization is that under Plan B the drawers would be serving a larger population of LCF and LF sites than the drawers provisioned for the support of only one Wing. As a consequence, the percentage deviation in depot drawer demands from the average depot drawer demand will be smaller than the range of demand fluctuations experienced using the base level support plan (see Exhibit #10).

(2) Electronic Cards - The electronic cards which are required for the repair of electronic drawers have a typical failure rate of approximately 0.25 failures per Wing per month. Under Plan A, a quantity of two to three of each card type is provisioned for each Wing. As a consequence, a total of approximately ten to fifteen of each type are required for the five Wings. In contrast, it is expected that one set of each card type would be required under Plan B.

(3) Mobile Test Sets - The decreased requirement for the mobile test sets would be the result of the same factors reviewed in explaining the decreased requirement for electronic drawers.

(4) Automatic Test Equipment - Under Plan B a much higher utilization of automatic test equipment can be realized. Under Plan A, regardless of the load on the equipment, at least one piece of each type of test equipment will be required at each Wing. As in the case of drawer demands, the demand load for the automatic test equipment would be leveled to a large extent under the depot repair plan.

(5) Repair Personnel - Under Plan B, the currently required SMSB repairs functions for high-cost, low-failure rate support elements would be transferred to the depot level. As a result, the requirement for SAC's SMSB repair personnel would be reduced by a total of approximately 144 men. On the basis of a total man-cost of $13,600 per year, this reduction is equivalent to a ten-year saving of $19,600,000 (net figure for personnel decrease and addition entries shown on Exhibit #34). A relatively high turnover of SAC repair personnel would be experienced in comparison to the civil service depot repair personnel. Training costs would accordingly be less, and it would be easier to maintain a high efficiency level.

(6) Log-Air Transportation - Since Plan B calls for Log-Air transportation of high-cost, low-failure rate items (electronic drawers, mobile test sets, etc.) to the depot for their required repair operations, an added flow of support elements between the depot and the Wings will result. These Log-Air flights would also be used to bring about joint usage of the support elements by the different Wings. In

recognition of the increased Log-Air loads that would be experienced under Plan B, a ten-year cost ($5,800,000) for an additional daily Log-Air flight has been charged to Plan B.

(7) <u>Weapon System Downtime</u> - A probability analysis was included in the exploratory LMI-Boeing study in order to quantify the amount of additional weapon system downtime that might be experienced when a Wing finds that it must obtain a required support element from either the depot or another Wing. The analysis revealed that the amount of expected increase in LF downtime amounts to 0.56 LF's. As shown on Exhibit #34, the equivalent ten-year value of this downtime ($3,900,000) is charged against Plan B.*

The gross indicated ten-year cost decrease for the depot repair plan (Plan B) was $42,900,000. If this depot repair plan had been conceived before the production release of the WS-133 A Program's** entire base repair plan's mobile test set and automatic equipment requirements, this full amount would have been available as a potential savings. The study revealed, however, that this equipment had already been released and essentially completed. Appropriate adjustments were accordingly made to reflect this equipment status and the current net estimated savings potential of Plan B is $34,200,000. This latter figure is believed to be of the correct order of magnitude if the Air Force elects to implement a depot repair similar to that called for by Plan B in the near-term future.

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* The cost of the similar Log-Air flight now in operation is approximately $575,000 per year.

** M^2 Wings I through V.

EXAMPLES OF TYPICAL PLAN B POTENTIAL SAVINGS

(SPARE M^2 ELECTRONIC DRAWERS)

	M^2 ELECTRONIC DRAWER PART NUMBER	DRAWER QUANTITIES REQUIRED		UNIT PROCUREMENT COST	DIFFERENCE IN PLAN COSTS	
		PLAN A	PLAN B		PROCUREMENT COST	10 YEAR COST
LF DRAWERS	25-22039-59	19	12	$49,920	$349,440	$562,298
	25-22040-63	14	13	15,450	15,450	24,874
	8323605	19	18	23,200	23,200	37,352
	8323661	11	7	21,750	87,000	140,070
LFC DRAWERS	8323657	6	3	27,520	82,560	132,922
	8324134	7	3	29,725	118,900	191,429
	8320793	6	3	14,500	43,500	70,035
	8323624	7	3	20,430	81,720	131,569

POTENTIAL DRAWER SAVINGS=$10,500,000 (10 YEAR COST)

EXHIBIT NO.35

EXAMPLES OF TYPICAL PLAN (B) POTENTIAL SAVINGS
(SPARE M^2 ELECTRONIC DRAWERS)

The Table shown on Exhibit #35 contrasts the optimum C/E quantity requirements for eight typical spare M^2 electronic drawers under Plans (A) and (B). The potential ten-year cost savings on these eight drawers alone is approximately $1,290,549 ($801,770 procurement cost). The estimated total M^2 electronic drawer savings of $10,500,000 was arrived at by making a comparison of the optimum C/E quantity under Plans (A) and (B) for each different spare M^2 LF and LCF electronic drawer. Although these are significant potential savings, larger benefits are expected in the areas of automatic test equipment and repair personnel when using Plan (B) as is shown on Exhibit #34.

M^2 DEPOT VERSUS BASE LEVEL REPAIR STUDY SUMMARY

RECOMMENDED ACTIONS

- AN IMMEDIATE DETAILED AIR FORCE C/E EVALUATION OF PLAN (B) FOR APPLICATION TO THE M^2 WS-133 A PROGRAM (WINGS I-V).
- A CONCURRENT C/E STUDY OF DEPOT REPAIR PLANS FOR HIGH COST LOW FAILURE RATE SUPPORT ELEMENTS REQUIRED FOR THE M^2 WS-133 B PROGRAM (WING VI AND ON) .
- A C/E COMPARITIVE ANALYSIS OF DEPOT VERSUS BASE LEVEL REPAIR PLANS FOR THE HIGH COST LOW FAILURE RATE SUPPORT ELEMENTS OF MAJOR DoD WEAPON SYSTEMS.

POTENTIAL BENEFITS

- $34,200,000 SAVING FOR THE M^2 WS-133 A PROGRAM (WINGS I-V).
- SIGNIFICANT SUPPORT SYSTEM HARDWARE COST AVOIDANCES FOR MAJOR DoD WEAPON SYSTEMS.
- MILITARY BASE LEVEL REPAIR PERSONNEL REQUIREMENTS CAN BE ADVANTAGEOUSLY REDUCED.
- GREATER C/E ADVANTAGE CAN BE TAKEN OF CONTRACTOR REPAIR CAPABILITIES.

EXHIBIT NO.36

M^2 DEPOT VERSUS BASE LEVEL REPAIR STUDY SUMMARY

RECOMMENDED ACTIONS

(1) An Immediate Detailed Air Force C/E Evaluation of Plan (B) for Application to the M^2 WS-133 A Program (Wings I-V) - In view of the rapid pace of the M^2 program and the significant potential savings to be derived by using a depot repair plan in place of the current base level repair plan for high-cost, low-failure rate support elements, it is recommended that the Air Force make an immediate and detailed C/E evaluation of the exploratory LMI-Boeing study. In considering this recommendation, attention is called to the fact that a depot repair plan very similar to Plan (B) has already been successfully implemented by the Air Force on the M^2 WS-133 A Program for the repair of the costly and mission essential M^2 guidance and control system.

(2) A Concurrent C/E Study of Depot Repair Plans for High-Cost, Low-Failure Rate Support Elements Required for the M^2 WS-133 B Program (Wing VI and on) - At the present time this (B) Program calls for the same type of base level support plan currently being used for the (A) Program. Since the (B) Program is still in its design stages, maximum advantage can be taken of the depot repair concept if action is taken by the Air Force now to develop an optimized C/E depot repair plan for this program. It is also suggested that an evaluation be made of the possible benefits that might be derived by utilizing a greater degree of contractor support on the (B) Program than was used on the (A) Program.

(3) A C/E Comparative Analysis of Depot Versus Base Level Repair Plans for the High-Cost, Low-Failure Rate Support Elements of Major DoD Weapon Systems - In

making this recommendation, LMI is aware of the military Services' general emphasis on having their weapon system support capability as close to the point of use as possible. As is the case with any general rule, however, periodic objective re-evaluations should be made in the interests of deriving optimum cost effectiveness. LMI is confident that the performance of C/E analyses of current and contemplated base level repair plans for high-cost, low-failure rate support items will reveal many cases where significant advantages can be derived if depot level repair plans are substituted for base level repair plans, particularly in cases where the repair systems are still in their planning or early implementation stages.

<u>POTENTIAL BENEFITS</u>

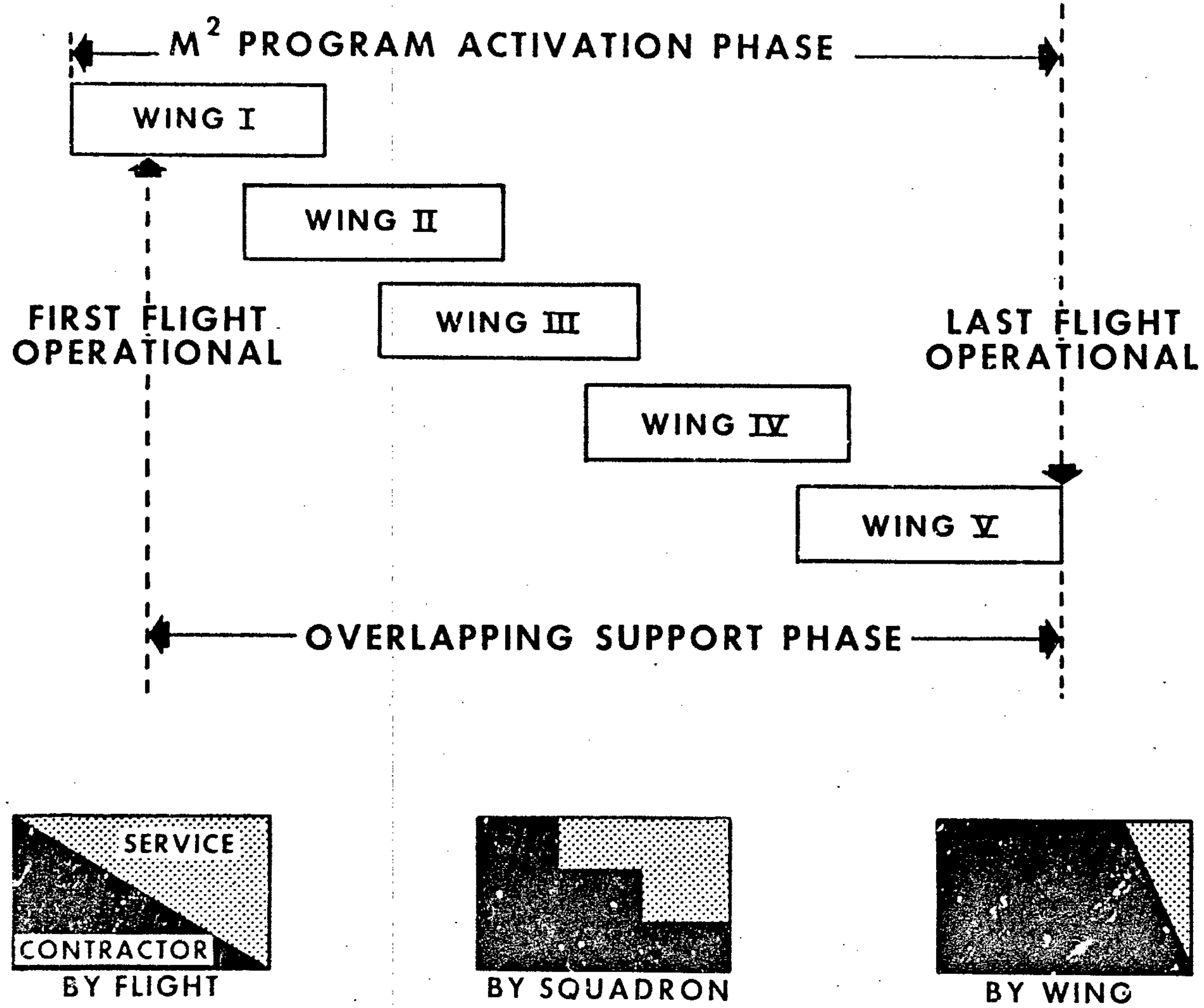
(1) <u>$34,200,000 Savings for the M^2 WS-133 A Program (Wings I-V)</u> - The basis of these savings was reviewed in conjunction with report Exhibits #33 through #35.

(2) <u>Significant Support System Hardware Cost Avoidances for Major DoD Weapon Systems</u> - It is expected that C/E analyses will reveal that, in general, high-cost, low-failure rate support elements for a weapon system can be repaired more advantageously at a single depot than at several different bases. The depot will be serving a larger population of weapon system units and the percentage deviation in depot support element demands from the average depot support element demand will be smaller than the range of demand fluctuations that will be experienced at the base level. A smaller supply of depot level support elements can, therefore, be provisioned since they will be more effectively utilized.

(3) Military Base Level Repair Personnel Requirements Can Be Advantageously Reduced - The same reason applies here as was stated in the case of the support element hardware, namely, higher utilization.

(4) Greater C/E Advantage Can Be Taken of Contractor Repair Capabilities - When C/E analyses indicate that a weapon system's repair operations can more advantageously be performed at centralized service depots, an increased opportunity exists to consider the use of contractor facilities for the performance of some or all of the repairs. Where highly specialized repair facilities, equipment and personnel are required, C/E analysis will often indicate that a contractor can perform the required support operations at a lower total cost than is possible in the Service.

C/E CONTRACTOR SUPPORT PHASING



BASIC M^2 WING SUPPORT PHASE-OVER ALTERNATIVES

EXHIBIT NO.37

C/E CONTRACTOR SUPPORT PHASING

As reviewed in the text accompanying Exhibit #23, the M^2 Wing support responsibilities are currently phased-over from Boeing to SAC/AFLC on a flight-by-flight basis. Three alternative plans involve phasing-over by flight; phasing-over on a squadron-by-squadron basis; and phasing-over on a total Wing basis. The general nature of the contractor support phase-over to the Service under these three plans is schematically portrayed on Exhibit #37. In the previous LMI Titan II and Minuteman studies, it was recommended that the program activation contractor supply and manage the required field and organizational level program spares at each base until the Wing's activation process had been completed. This recommendation was implemented on the Titan II Program in early 1963 for all the joint usage contractor-Service spares. Although the Air Force did not implement the recommendation for the M^2 WS-133 A Program, it is being evaluated for possible application to the M^2 WS-133 B Program (Wing VI and on). In considering the recommendations stated below, it should be noted that the Titan II and M^2 WS-133 A activation contractors are supplying each Wing's RPIE* spares support until 45 days after the Wing's acceptance by SAC.

In view of the foregoing considerations, it is recommended that the Air Force take the following actions:

(1) Perform a C/E analysis of the potential benefits which may be derived by having Boeing supply the total M^2 spares support at M^2 Wings IV and V until

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* Real Property Installed Equipment

approximately 30 to 45 days before SAC's final Wing acceptance. This lead time is recommended to allow a smooth phase-over of the spares management to SAC/AFLC personnel.

(2) Utilize C/E analyses techniques in establishing the mix of contractor and Service support for the M^2 WS-133 B Program (Wing VI and on). The C/E analysis should encompass all levels of support as significant savings may possibly be derived by deferring the establishment of Service SRA capabilities for the M^2 WS-133 B Program, particularly if more than one Wing is involved in the (B) Program.

B. RESIDENT SUPPORT TEAMS

AIR FORCE AND CONTRACTOR M^2 SUPPORT ASSETS

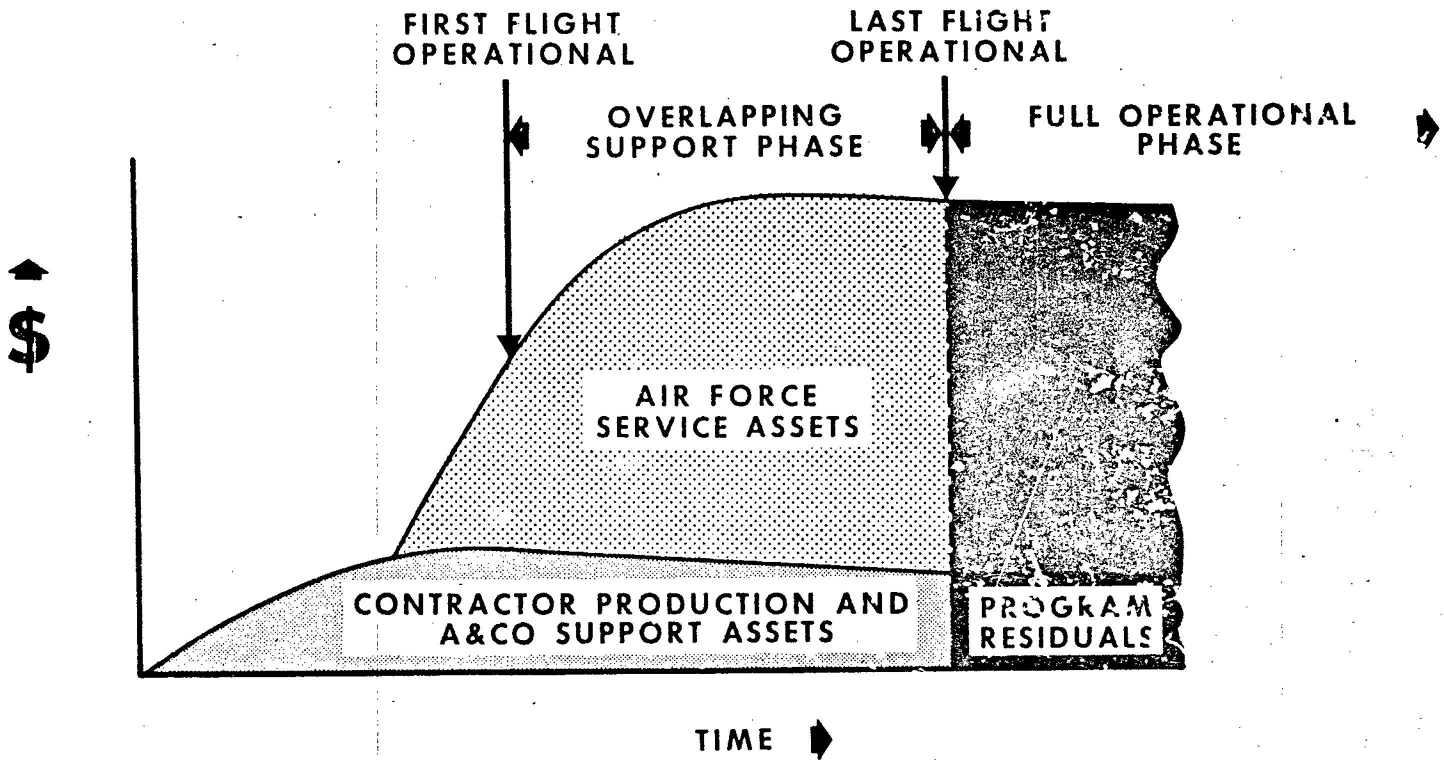

EXHIBIT NO.38

AIR FORCE AND CONTRACTOR M^2 SUPPORT ASSETS

The degree to which excessive M^2 program support costs and residuals will be minimized depends upon the adequacy of the program's over-all support planning and management with respect to the joint usage of support assets and optimum utilization of contractor support system knowledge and capabilities.

Exhibit #38, which is a general portrayal of the Air Force and contractor M^2 support assets positions during the various program phases, shows how joint usage can minimize support costs and residuals.* In order to discharge their M^2 production and activation program missions, contractor support assets are required at M^2 Wings as well as at the contractors' production facilities. Upon completion of the production and A & CO program phases, these support assets will be excess to the contractors' needs. The degree to which the Air Force has based support asset procurement upon this fact controls the amount of excessive program residuals that will be incurred.

Although the motivating force behind the Air Force's establishment of the Titan II RPT was the necessity for a greatly expedited Titan II provisioning cycle, the Titan II RPT has also played the key role in joint usage management planning for Martin spares. In recognition of the support system impact that other organizations (primarily BSD, SAC and ATC) had, LMI recommended that the RPT concept be enlarged to include those organizations so as to assure consideration of all support system assets. In view

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* The 6 July 1962 LMI report, "Initial Provisioning," and the 22 March 1963 LMI report, "Minuteman Initial Support Study," contain detailed discussions of the importance of joint Air Force-contractor usage of support assets.

of their broader support system roles, these recommended teams were called Resident Support Teams (RST's). As covered in earlier report text, the RST recommendations were partially implemented by the Air Force at the Boeing and Autonetics plants for the M^2 WS-133 A Program. While very significant savings have been experienced on both the Titan II and M^2 Programs as the result of resident team efforts, the benefits derived can be significantly increased by a full-scale implementation of the RST concept. The additional Air Force actions called for are reviewed in the text accompanying the following series of exhibits and are necessary if support system costs are to be optimized with respect to the potential benefits of:

- Joint usage of contractor and Service support assets; and
- Utilizing contractor support system knowledge and capabilities.

OPTIMUM SUPPORT SYSTEM RESPONSIVENESS

- **FACT:**
  - ALL INITIAL SUPPORT SYSTEMS ARE UNBALANCED IN THEIR EARLY PHASES
- **PROBLEM:**
  - TO OBTAIN AN OPTIMUM DEGREE OF SUPPORT SYSTEM RESPONSIVENESS AS REQUIRED TO:
    - BALANCE THE SUPPORT SYSTEM PROVIDED
    - CAPITALIZE ON IMPROVEMENT OPPORTUNITIES
- **KEYS TO C/E SUPPORT:**
  - THE EARLY IDENTIFICATION OF REQUIRED CHANGES
  - THE TIMELY IMPLEMENTATION OF IMPROVED PLANS
- **CONCLUSION:**
  - CONTINUOUS SUPPORT SYSTEM ANALYSIS AND REFINEMENT ARE ESSENTIAL TO THE REALIZATION OF OPTIMIZED C/E SUPPORT SYSTEMS.

EXHIBIT NO.39

OPTIMUM SUPPORT SYSTEM RESPONSIVENESS

This report thus far has been restricted to a review of a support system's basic elements and the concept of procuring support systems in integrated packages; and a review of C/E support planning techniques and their recommended areas of application. The material which follows contains a discussion of an improved means of applying and improving support system management techniques through the use of Resident Support Teams (RST's). At the outset, some of the general characteristics of weapon support systems which led to the development of the RST concept are briefly described.

No matter how much care is used in formulating and implementing support plans for a major weapon system (Titan, M^2, F-4, Polaris, F-111, etc.), it is an inescapable fact that the support systems will be unbalanced during their early usage phases. In short, regardless of whether sophisticated C/E or "best judgment" methods are used for its design and implementation, the initial support system will be characterized by imbalances between that which has been provided and planned for and that which is actually required to achieve optimum C/E support. This is because today's support system plans must be formulated and partially executed upon the basis of predicted needs rather than exact measures of requirements. As is the case with all prediction techniques, experience will reveal a high percentage of variances between actual and predicted requirements and for a variety of reasons. Moreover, as support personnel become more familiar with their weapon system, many support system improvement opportunities will become apparent. The management problem posed by these facts is that of obtaining an optimum degree of support system responsiveness as required to:

- Obtain the most C/E balance between the support elements provided and actual system needs; and

- Capitalize on support system improvement opportunities in general.

The keys to this problem are the early identification and timely implementation of the required support system changes. For example, joint usage of contractor and Service support assets must be recognized and planned for early, if excessive program support residuals are to be avoided. The same holds true with respect to such concepts as deferred or phased procurements, M^2 mobile relief repair teams and the use of depot rather than base level repair plans.

The conclusion to be drawn from the foregoing facts is that continuous support system analysis and refinement is essential to the attainment of optimized C/E support performance. For a number of reasons which are brought out later in this report, this work needs to be done by Service personnel with the assistance of contractor personnel; the work period covers several years; and the work site needs to be in or closely adjacent to the key support system contractor's main facilities. These requirements can all be met by the use of RST's.

RESIDENT SUPPORT TEAMS

CONCEPT:

- REPRESENTATIVES FROM VARIOUS SERVICE COMMANDS ESTABLISHED AT A MAJOR WEAPON SYSTEM'S KEY CONTRACTOR PLANTS FOR EXTENDED TIME PERIODS TO FACILITATE SUPPORT SYSTEM INTEGRATION AND REFINEMENT.

OBJECTIVE:

- OBTAIN IMPROVED WEAPON SYSTEM SUPPORT EFFECTIVENESS AT REDUCED COSTS.

INHERENT ADVANTAGES:

- VARIOUS SERVICE ELEMENTS CAN DISCHARGE THEIR INDIVIDUAL RESPONSIBILITIES IN A MORE COORDINATED MANNER AND WITH MORE CURRENT AND COMPREHENSIVE DATA THAN PRACTICAL WITH OTHER ARRANGEMENTS.
- THE SHORTER,FASTER,AND MORE ACCURATE SERVICE-CONTRACTOR COMMUNICATION LINES PERMIT GREATER SUPPORT SYSTEM RESPONSIVENESS TO REQUIRED CHANGES AND IMPROVEMENT OPPORTUNITIES.
- CREATES AN ENVIRONMENT WHICH WILL MOTIVATE IMPROVED PERFORMANCE BY MAKING IT POSSIBLE TO HOLD SPECIFIC PERSONNEL RESPONSIBLE FOR SUPPORT SYSTEM DECISIONS AND ACTIONS

EXHIBIT NO.40

RESIDENT SUPPORT TEAMS

A major weapon system's acquisition program involves many different military and contractor organizations, all or most of which are widely separated geographically. A critical and complex support management problem stemming from this situation is that of assuring that the various program participants' initial support plans and actions are well integrated and highly responsive to changes in support system requirements. As one means of facilitating the achievement of these desired ends, LMI developed and recommended the concept of Resident Support Teams (RST's).

The RST concept is a logical enlargement of previous LMI recommendations for Air Force Resident Provisioning Teams (RPT's). Although the terms Resident Provisioning Teams and Resident Support Teams are quite similar, there are very significant differences in their recommended charters. For example, the Air Force RPT's are primarily concerned with performing provisioning functions for operational program spares, whereas the recommended RST's have broader support system functions.* In contrast to the RPT's, which are essentially extensions of AFLC organizations, the recommended RST's are made up of representatives of a number of commands. For example, the recommended M^2 RST's would include personnel from OOAMA, BSD, SAC and ATC.

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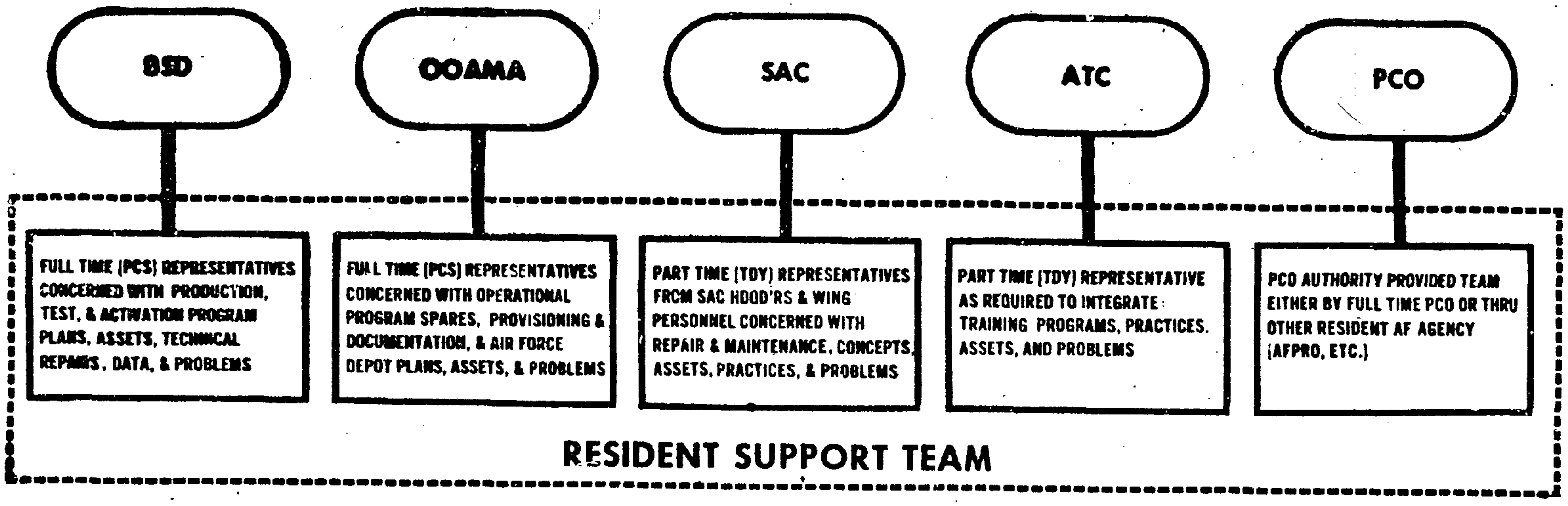
* A detailed description of the RPT concept appears in Section VIII of the 6 July 1962 LMI report, "Initial Provisioning--Interim Report #1." The "SECRET" 22 March 1963 LMI report entitled "Minuteman Initial Support Study" describes the RST concept and review prior RST recommendations.

M^2 RESIDENT SUPPORT TEAMS



1. NO AIR FORCE REORGANIZATION REQUIRED. TEAM ELEMENTS ARE DECENTRALIZED EXTENSIONS OF PRESENT ORGANIZATIONS RESPONSIBLE FOR REPRESENTING AND COMMITTING THEIR PARENT ORGANIZATIONS IN CONSONANCE WITH SPECIFIC DUTY ASSIGNMENTS.

2. DUTIES, RESPONSIBILITIES, & AUTHORITIES OF EACH TEAM ELEMENT ESTABLISHED BY ITS PARENT ORGANIZATION. THESE SHOULD BE ASSIGNED IN A MANNER WHICH PERMITS THE DEGREE OF RESPONSIVENESS REQUIRED TO REACT TO DYNAMIC SUPPORT SYSTEM NEEDS AND IMPROVEMENT OPPORTUNITIES.

3. PRIMARY PARTICIPANTS WOULD BE BSD, OOAMA, PCO, AND CONTRACTOR PERSONNEL WITH FREQUENT SAC PARTICIPATION.

4. ESTIMATED RANGE OF REQUIRED MANNING FOR M^2 RST'S AS BASED UPON LMI'S RECOMMENDED TEAM FUNCTIONS AND ACTIONS.

FULL TIME REPRESENTATIVES *	BOEING RST	AUTONETICS RST
BSD	2	1
OOAMA	8	5
PCO	1	1

* FREQUENT SAC REPRESENTATION ON BOEING RST AND OCCASIONAL ATC REPRESENTATION ON BOTH RST'S.

EXHIBIT NO. 41

In recognition of the need for the continuous review and refinement of the M^2 initial support system, as well as the fact that much of the data required are initially available only at the contractors' plants, LMI recommended that the Air Force establish RST's at the Boeing and Autonetics plants. That recommendation was designed to facilitate the attainment of an optimum support system for the M^2 Program in the shortest possible time and to provide a sound basis for evaluating the benefits to be gained by using RST's on additional weapon system programs. RST's facilitate the achievement of an optimum support system by:

- Placing knowledgeable Service personnel in close and continuous working contact with one another, and with ready access to the data and personnel resources of the contractor, to permit a maximum interchange of their specialized support system knowledge and experiences; and

- Creating an environment which will motivate improved performance by making it possible to hold specific personnel responsible for support system decisions and actions.

In addition to the actions taken by the Air Force which have partially implemented the M^2 RST's at Boeing and Autonetics, it is recommended that the Air Force:

(1) <u>Develop and Apply Team Performance Measures</u> - This recommendation was made by LMI in both its Titan II and M^2 reports. Such measures are needed to motivate the teams to higher effectiveness and efficiency and to help the members of the teams to maintain their Service orientation and objectivity during long tours of duty on the premises of contractors.

The RST concept calls for balanced teams to be established at key support

contractor plants on a resident basis for extended time periods for the purpose of performing, with data and assistance from the contractor, continuous tasks to derive improved weapon system support effectiveness at reduced costs. The RST approach to the provision of C/E support permits the several commands involved to discharge their individual responsibilities in a more coordinated manner and with more current and comprehensive data at hand than has been possible with other arrangements. In order to establish an RST it is not necessary for any of the commands involved to transfer any of their functions to any of the others. It is only necessary for each command to make an assignment of specific duties to its chief representative at the contractor's plant; that the duty assignments made by all commands be harmonious and consistent; and that the members of the RST work in voluntary coordination among themselves (see Exhibit #41).

Because of the dynamic nature of the support system requirements* and the support plan improvement opportunities that will be revealed as program experience is gained, the geographic distances separating these organizations pose difficult support integration problems since the achievement of optimum C/E support requires that continuous, integrated decisions be made and acted upon with respect to the support system.

(2) <u>Assign to the RST's Responsibility for the Day-to-Day HI-VALU Management Functions</u> - In recognition of the fact that all of the M^2 HI-VALU spares are included in the M^2 joint usage plans, it is recommended that the teams be charged with their day-to-day management control. This recommendation was originally made in late

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* See the text of Exhibit #23 for a review of the factors contributing to this condition.

1962, but has not been conclusively evaluated. It is suggested that in the evaluation consideration be given to:

- Rather infrequent meetings of the formal HI-VALU review boards;
- The RST's detailed and current knowledge of program requirements for the HI-VALU joing usage spares;
- The dynami~ nature of the logistics failure rates experienced on the M^2 Program (see Exhibit #44); and
- The large population of contractor A & CO HI-VALU spares.

(3) Assign to the RST's Responsibility for Performing Competitive Spares Breakout Analyses - Because many of the same considerations are applicable to spares provisioning and to competitive breakout decisions, it is recommended that the RST's be assigned the duty of performing the competitive breakout analyses. Since the factors controlling the breakout decision are dynamic (design stability, failure rates, process problems, etc.), it will be necessary to review these factors periodically as the program advances. Available alternatives to this recommendation of which LMI is aware appear to be more costly and less effective in assuring optimum competitive decisions.

(4) Assign to the RST's Liaison Duties in Connection with the M^2 WS-133 B (Wing VI and on) Support Planning - Because of their location at the two key support program contractor facilities and their depth of experience and knowledge on the very similar M^2 WS-133 A Program, it is recommended that the RST's at Boeing and Autonetics

act as focal points for the coordination of contractor and Air Force support system planning and refinement.

(5) <u>Make the RST's Responsible for Developing Refined Support System Plans</u> - Because of their over-all system knowledge and location, the RST's are in an ideal position to spearhead efforts to continuously refine the M^2 support system plans. For example, the RST's are in position to make significant contribution to the evaluation and implementation of recommendations covered earlier in this report relative to such things as:

- The refinement of the M^2 provisioning model (see Exhibit #24);
- The use of C/E techniques for M^2 mobile repair teams (see Exhibit #25);
- Optimized C/E repair cycles (see Exhibits #26, #27 and #28);
- Relief M^2 mobile repair teams (see Exhibits #29, #30 and #31);
- The three basic repair decisions described in the text accompanying Exhibit #32;
- The increased use of M^2 depot repair for high-cost, low-failure rate items (see Exhibits #33, #34, #35 and #36); and
- The C/E utilization of contractor support (see Exhibit #37).

(6) <u>Make the RST's Responsible for the Refinement of the M^2 A & CO and Air Force Spares Requirements</u> - By reason of their location at the key support contractor plants, the RST's are in an excellent position to initiate the actions required to

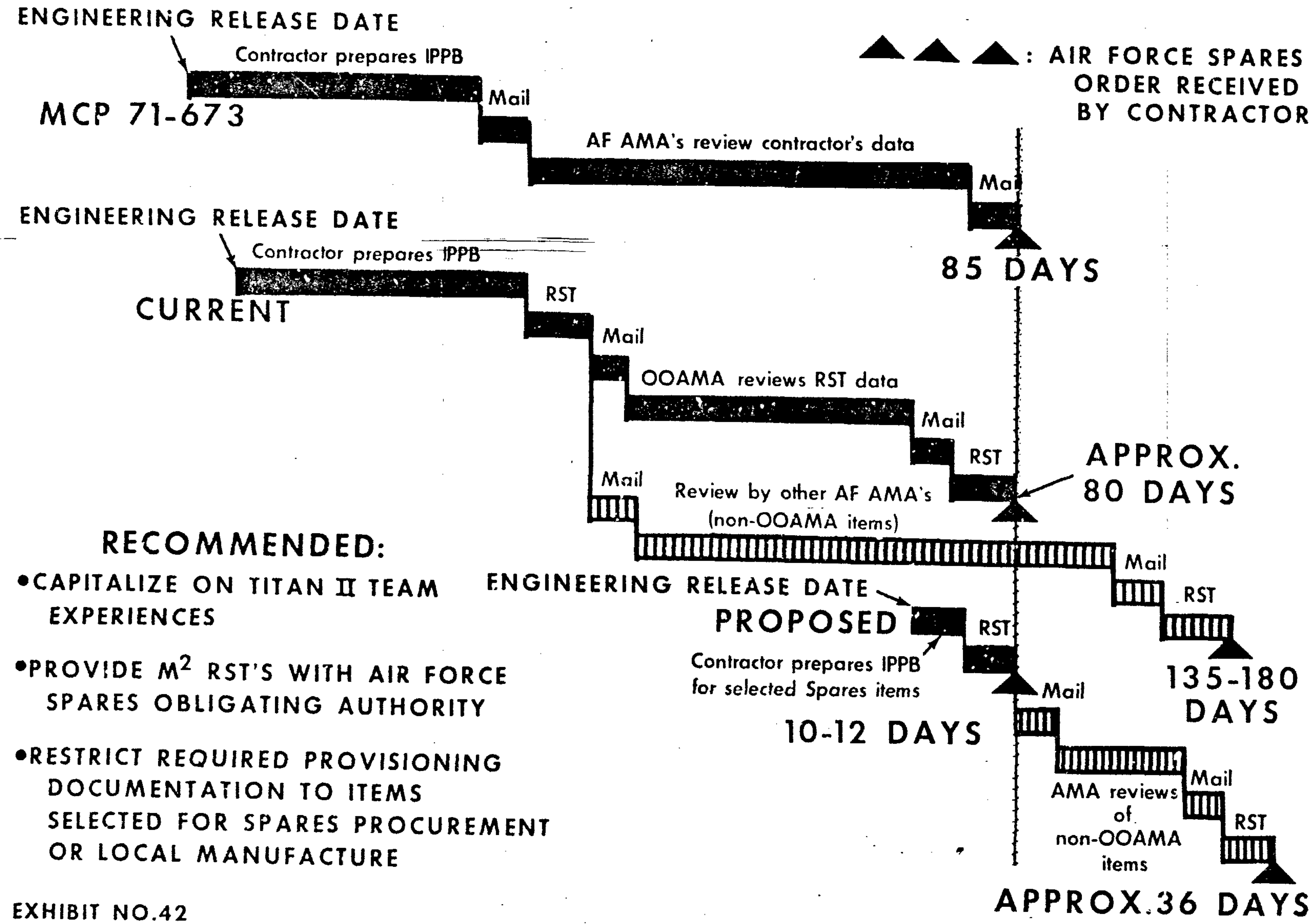
derive the best balance between the Air Force and contractor spares procurement programs. As described earlier in this report, a very dynamic situation exists with respect to support system requirements. As a result, there is a wide variation between design failure rates and the failure rates (logistics failure rates) that should be utilized for support planning purposes. The RST's are in position to get the most current experience data and to continuously refine and improve the accuracy of predictions of M^2 logistics failure rates. The RST's are strategically placed for working out the details of plans for joint Air Force-contractor usage of spares. During the most recent study of the M^2 Program, it was learned that an opportunity exists to refine the joint spares usage plans by using refined logistic failure rates and improved methods for A & CO spares requirements determinations. The RST's would be expected to take advantage of advances such as these in the calculation of spares requirements and related work.

In summary, the full implementation of LMI's M^2 RST recommendations would:

- Secure faster decisions with respect to support matters;
- Improve the integration of Service support plans and actions;
- Greatly improve communications between the Services and the contractors relative to their closely interrelated support system roles;
- Obtain continuously and currently data on changes in support system requirements;
- Materially improve responsiveness to the dynamic support system requirements;

- Make more refined and more accurate support decisions;
- Accelerate actions toward continuous support system improvements;
- Perform competitive spares breakout analyses in a more economical and effective manner than appears possible through use of other available methods; and
- Significantly improve management control over support system matters.

COMPARISON OF SPARES PROVISIONING CYCLES



RECOMMENDED:

- CAPITALIZE ON TITAN II TEAM EXPERIENCES
- PROVIDE M^2 RST'S WITH AIR FORCE SPARES OBLIGATING AUTHORITY
- RESTRICT REQUIRED PROVISIONING DOCUMENTATION TO ITEMS SELECTED FOR SPARES PROCUREMENT OR LOCAL MANUFACTURE

EXHIBIT NO.42

COMPARISON OF SPARES PROVISIONING CYCLES

Exhibit #42 displays and compares planned, actual and proposed provisioning cycles as:

- Called for by the applicable M^2 program provisioning specification (MCP 71-673);
- Being experienced during the time period of 22 April through 22 June 1963; and
- Recommended by LMI.

An examination of this exhibit will disclose that no significant savings in time or reductions in documentation were being obtained as a result of the partial implementation of RST's at Boeing and Autonetics.

The Incremental Provisioning Parts Breakdown (IPPB) called for under MCP 71-673 had not been restricted to cover only those items selected for spares procurement or local manufacture as recommended by LMI to the Air Force. That recommendation was made in view of the fact that OOAMA personnel had advised that the information supplied by the 100% IPPB for non-spare items could readily be obtained from other documentation. The undesirable results of the 100% IPPB requirement include:

(1) Excessive documention costs;

(2) An unnecessarily long provisioning cycle; and

(3) Distortion of spares procurement costs.

LMI has recommended that the Air Force reconsider the 100% IPPB requirement, taking into account the following:

(1) The 100% IPPB requirement is not a requirement on the Titan II ICBM Program which has support requirements similar to those of the M^2 Program;

(2) It is LMI's understanding that the 100% IPPB requirement has been applied only to Boeing and Autonetics and has not been applied to the other associate M^2 contractors; and

(3) Although the M^2 WS-133 A Program is fairly well advanced at this date, the magnitude of the dollar savings possible on this program are still significant. The full dollar savings potential can be derived on the M^2 WS-133 B Program which is still in its early stages.

Another factor contributing to the lengthy provisioning cycle time being experienced on the M^2 Program is the fact that spares obligating authority has not been provided to the RST's at Boeing and Autonetics. By providing this authority, the provisioning cycle for OOAMA prime items can be further reduced by approximately 45 days.* By adopting the LMI recommendations relative to IPPB's and spares obligating authority, the provisioning cycle for OOAMA prime items can be reduced to a total of approximately 10 to 12 days as compared to the current 80-day cycle.

With respect to the non-OOAMA items, LMI had recommended that the Air Force take

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* Upon reviewing the degree to which Boeing RST spares recommendations were changed during subsequent review, Boeing and Air Force RST personnel reported that they are rarely experienced.

steps to assure that the required AMA decisions be received within a maximum of 21 calendar days. If this recommendation is acted upon, the required provisioning cycle for non-OOAMA items can be reduced from the current cycle of approximately 135 to 180 days to about 36 days.

These recommended changes in the provisioning process would bring about significant reductions in administrative and documentation costs. The primary benefit would, however, be in the form of improved provisioning actions by the R3T since they would be based upon considerably more experience data relating to usage analysis and future failure rates. LMI believes that these changes can be made safely. This belief is supported by the fact that the administrative systems developed and successfully applied to the Titan II Program for a considerable period of time incorporate features similar to those recommended.

DYNAMIC NATURE OF FAILURE RATES

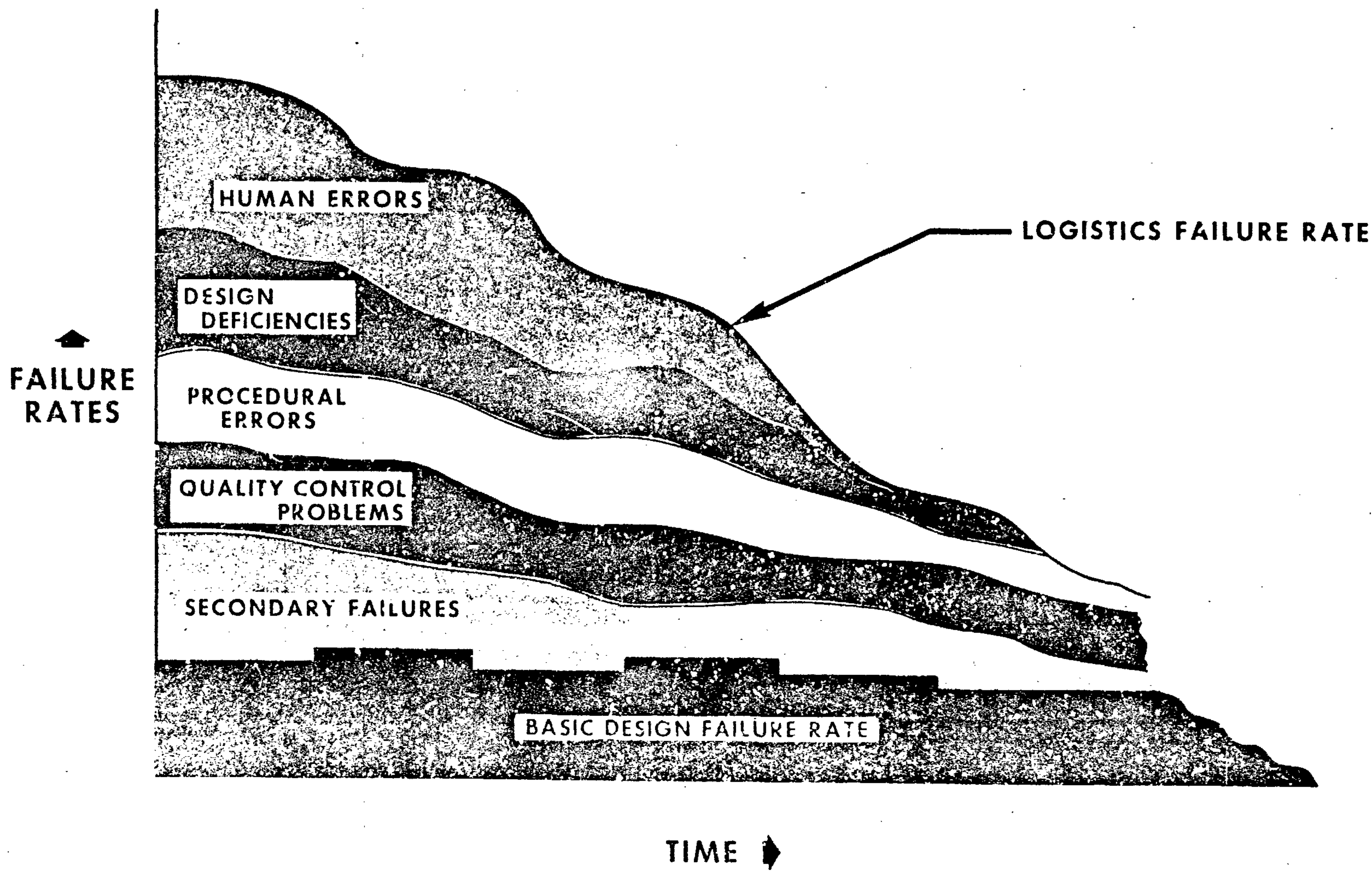

EXHIBIT NO.43

DYNAMIC NATURE OF FAILURE RATES

During the course of its M^2 project studies, LMI became aware of a support system communications problem caused by the various ways in which the term "failure rate" was used by different groups. For instance, an equipment designer usually speaks of an equipment's failure rate as the rate at which failures are experienced in his designed piece of equipment when it is operating as designed and in the environment for which it was designed. This may be called the equipment's basic design failure rate. A reliability engineer, however, generally thinks of an equipment's failure rate in terms of the factor that actually caused the equipment to fail. For example, he might categorize the failure into one of those portrayed on Exhibit #42 (human errors, designer deficiencies, etc.).* Still another viewpoint is found with weapon system logisticians and support personnel. They are concerned with the failure rate which they must support regardless of failure causes. This last failure rate is shown on Exhibit #43 as the Logistics Failure Rate of the piece of weapon system equipment under consideration.

An equipment's basic design failure rate is relatively stable. In contrast, the logistics failure rate is very dynamic because of the changing rate at which equipment failures are caused by such factors as human errors and procedural errors. Moreover, the absolute magnitude of the logistics failure rate and the rate at which its

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* The relative proportions shown on Exhibit #43 were assumed for illustrative purposes only. Those experienced with actual pieces of weapon system equipment would provide an infinite variety of patterns.

absolute value approaches the basic design failure rate are controlled by management practices. Accordingly, its rate of change (growth or decline) is subject to available prediction disciplines. By taking full advantage of the fact that the logistics failure rate is both controllable and predictable, significant support system benefits can be derived. For example, Air Force spares requirement calculations typically employ approved BSD equipment design failure rate data whereas the contractor A & CO spares requirement calculations use a quadrupled value of the basic failure rate. The support conditions for both the A & CO and initial operating periods of the M^2 Program, while not identical, are quite similar. It is believed, therefore, that greater consistency should be sought between the Air Force and A & CO spares requirements determination methods. It is recommended that the RST's be assigned responsibility for seeing that greater consistency is achieved. It is further recommended that the RST's be made responsible for:

- Obtaining and using logistics failure rate predictions;
- Developing methods with contractor personnel to accelerate the rate at which the logistics failure rates approach the design failure rates at Wings III, IV, V, VI and on; and
- Causing a refined A & CO spares calculation method to be used in the immediate future.*

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* This recommendation is concerned with such things as the present A & CO failure rate method and is discussed in further detail in the text accompanying the next exhibit.

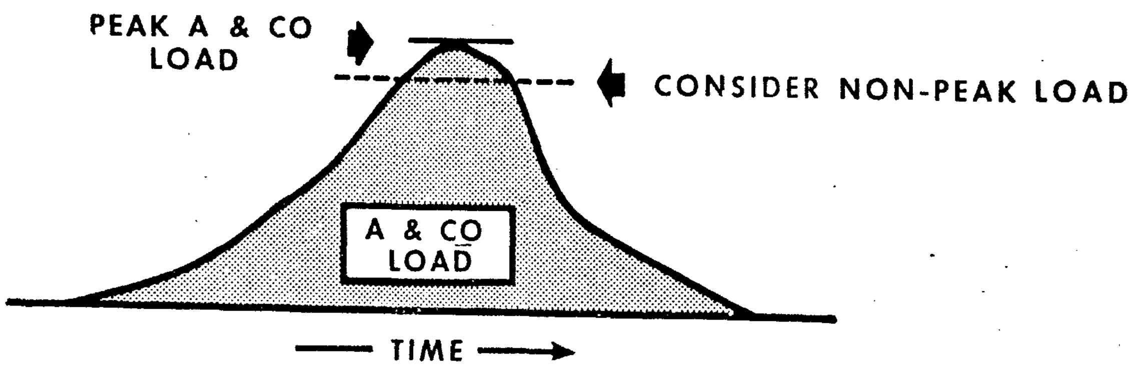
It should be noted that large-scale M^2 reliability failure analysis programs are currently being pursued. The data and knowledge gained by these efforts should be directly applicable as a means of making predictions of future logistics failure rates. Moreover, RST's can employ the failure analysis knowledge to influence the rate at which greater consistency is obtained between logistics and design failure rates.

M^2 A & CO SPARES REQUIREMENT DETERMINATION

- **A & CO SPARES CALCULATION:**

$$\text{QUANTITY OF A \& CO SPARES} = \left[\frac{\text{BSD APPROVED FR*}}{\text{EQUIP. POPULATION}}\right] \times \left[\text{"K" FACTOR}\right] \times \left[\text{PEAK A \& CO MONTHS LOAD}\right]$$

SAMPLE: FIG A 1201 $\left[\frac{1.96}{150}\right]\left[4\right] \times \left[82\right] = 4.3 \left[\begin{matrix}\text{PROVISION} \\ \text{5 SPARES}\end{matrix}\right]$



- **IMPACT OF SELECTED "K" FACTOR AND A & CO LOAD**

IF K=3.5 & PEAK A & CO LOAD IS USED (82); BUY 4 SPARES

IF K=3.0 & 3 MONTH AVERAGE A&CO LOAD IS USED (74.6); BUY 3 SPARES

- **RECOMMENDED :**

CONTINUOUS REFINEMENT OF M^2 A & CO SPARES REQUIREMENTS DETERMINATION

* FR = FAILURE RATE (FAILURES/WING/MONTH)

EXHIBIT NO.44

M^2 A & CO SPARES REQUIREMENT DETERMINATION

Exhibit #44 illustrates the method used by Boeing personnel to determine their A & CO spares requirements. Early in the M^2 Program, Boeing reliability engineering personnel selected a constant value of four to be used as a multiplier of the basic design failure rates in the calculation for A & CO spares requirements. The purpose of this multiplier ("K" factor) is to account for the variances expected between the design and logistics failure rates.* As a result of a review of this current A & CO calculation method, it is recommended that:

- Refined values for the "K" factor be immediately developed based upon A & CO experience to date and reliability failure analysis data. It is believed that the values arrived at by such methods** could also be used by Air Force personnel for their spares calculations with only minor adjustments required to account for the different spares usage conditions in A & CO and initial operational programs; and

- The refined "K" factors for the A & CO and initial operating program be immediately applied to the current M^2 spares programs.

It is also recommended that a re-evaluation be made of the current practice of using peak A & CO loads in the A & CO spares calculation. As reviewed in the text accompanying Exhibit #10, it is recommended that C/E analyses techniques be used to

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* Reviewed in the text accompanying Exhibit #43.

** It is expected that these analyses will reveal the desirability of using a series of "K" factors rather than a constant value of four.

identify the demand level to be supported. It is further recommended that C/E techniques be used to determine the optimum A & CO spares repair cycle time to use as a basis for A & CO spares requirements determination. As reviewed in the text accompanying Exhibit #24, it is believed that the C/E model approach should also be considered for application to A & CO spares.

The potential significance of these recommendations is indicated by the sample calculations shown on Exhibit #43. These calculations show that very minor value changes for the "K" factor and the demand level can change the spares quantity by one or two units. When this fact is considered in conjunction with the typical spare electronic drawer cost of approximately $20,000 and the fact that over 70 different drawer types are involved in the LF and LCF sites, it is apparent that the dollar impact is likely to be in excess of $1,000,000.

C. OVER-ALL SUPPORT MANAGEMENT

RECOMMENDATIONS ON OVERALL SUPPORT MANAGEMENT

- OBTAIN EXPANDED UTILIZATION OF C/E SUPPORT MANAGEMENT TECHNIQUES IN ALL SERVICES.
- PROVIDE DoD GUIDANCE TO SERVICES ON DESIRED C/E SUPPORT APPLICATION AREAS.
- OBTAIN BENEFITS INHERENT IN CONTRACTING FOR WEAPON SYSTEM SUPPORT ELEMENTS IN AN INTEGRATED PACKAGE.
- OBTAIN DoD WIDE APPLICATION OF RST CONCEPT ON ALL MAJOR WEAPON SYSTEM PROGRAMS.

EXHIBIT NO.45

RECOMMENDATIONS ON OVER-ALL SUPPORT MANAGEMENT

(1) Obtain Expanded Utilization of C/E Support Management Techniques in All Services - Although a great amount of research effort has been expended over the past several years to develop and publicize various ways in which systematic C/E analysis techniques can be advantageously utilized for DoD support systems, the number of large-scale applications of these techniques is relatively small. In view of the important advantages that are inherent in the use of C/E techniques, it is recommended that appropriate DoD actions be taken to bring about significant expansion of the use of the techniques in planning and evaluating major support system management functions. The basic techniques reviewed in this report are applicable to support planning and management in all major weapon system programs.

(2) Provide DoD Guidance to Services on Desired C/E Support Application Areas - In order to assist the Services in expediting their expanded utilization of C/E support management techniques, it is recommended that DoD guidance be furnished to them as to the areas and ways in which the techniques should be applied. It is suggested that they be requested to develop large-scale application programs to cover the following areas:

- Planning weapon system procurement program size and readiness posture;
- The repair versus throw-away spares decision;
- The repair level decision;

- The repair source decision (optimum mix of Service and contractor support);
- The selection and control of repair cycles;
- The formulation and refinement of weapon system maintenance operations;
- The determination of manpower requirements;
- The use of C/E provisioning models; and
- The use for support system funds planning and management.

(3) <u>Obtain Benefits Inherent in Contracting for Weapon System Support Elements as an Integrated Package</u> - LMI believes that the interrelationships which exist among a weapon system's major elements are so important that the elements should be planned and where possible, managed as an integrated whole. It is recommended, therefore, that new weapon and other very large systems' support elements on programs such as M^2 WS-133 B, F-4, C-141, F-111, etc. be contracted for as an integrated package. This practice would:

- Permit the more accurate identification and measurement of support system costs in terms of their details and their total;
- Provide an improved basis for the application and administration of incentive contracts for support system functions;
- Facilitate cost trade-offs among various Service and contractor organizations involved in the support system; and

- Augment the current program packaging system by improved knowledge and control of the weapon system's support costs.

(4) Obtain DoD-Wide Application of the RST Concept on All Major Weapon System Programs - It is LMI's belief that the use of adequately manned RST's with specific assigned duties, including, where necessary, delegated authority to act, can bring about improved weapon support systems at a greatly accelerated rate. The improved Service-contractor communications that are inherent in the RST concept will increase both the:

- Effective responsiveness of the Service and its contractors to the dynamic nature of support system requirements; and

- The rate at which improved support plans and methods are identified and implemented.

These two essentials to optimum C/E support will be derived using RST's because of:

- The shorter, faster, and more accurate communication lines established among the several Service organizations involved and between the Services and their key support system contractors; and

- The improved performance incentive environment created by virtue of the ability to more closely identify support system decisions with individuals in Service and contractor organizations.

It is suggested that the RST concept be planned for immediate full-scale implementation on the Minuteman and F-4 Programs. In addition to the types of benefits reviewed in this report, these actions will permit the concept's further refinement for application to such programs as the C-141 and the F-111.